Journal of Scientific Research and Development 2 (3): 133-135, 2015
Available online at www.jsrad.org
ISSN 1115-7569

Evaluation of nitrogen removal from agricultural runoff via constructed wetlands

Ali Afrous [1,*], Shahram Goudarzi [2]

[1]Department of Water Engineering, Dezful Branch, Islamic Azad University, Dezful, Iran
[2]Department of Soil Sciences, Dezful Branch, Islamic Azad University, Dezful, Iran

Abstract: Constructed wetlands can be an important role in removing pollutants such as pesticides and nutrients special nitrogen from agricultural runoff. The primary benefit of vegetation in wetlands is its ability to reduce chemicals, organic and suspended solids, also another benefit is that the plant and associated litter layer provides natural habitat for beneficial microbial organisms. Aquatic plants treated polluted water by storing its nutrients in biomass. Recent studies have shown the importance of aquatic vegetation for removal nitrogen through wetlands and agricultural drainage ditches.

Key words: Nitrogen; Aquatic plants; Removal

1. Introduction

Constructed wetlands are man-made systems, designed and constructed to treat wastewater using the natural processes typical of natural wetlands. These natural processes are an interaction and combination of wetland plants, soil and microbial life. Constructed wetlands can be classified according to the water flow regime: surface flow systems and subsurface flow systems. Constructed wetlands with subsurface flow may be classified according to the direction of flow into horizontal subsurface flow (HSSF) and vertical subsurface flow (VSSF). Vymazal (2001) classified constructed wetlands for treatment of domestic and industrial wastewaters, agricultural runoff and etc. in Table 1.

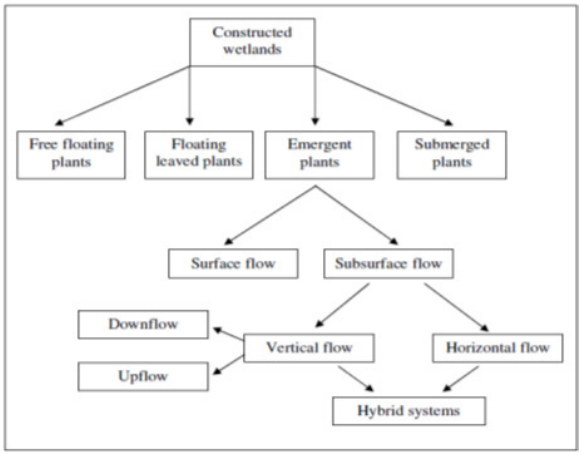

Fig. 1: Classification of constructed wetlands for wastewater treatment (Vymazal, 2001)

2. Processes of nitrogen removal in constructed wetlands

The dominant forms of nitrogen in wetlands that are of importance to wastewater treatment include organic nitrogen, ammonia, ammonium, nitrate, nitrite, and nitrogen gases. Inorganic forms are essential to plant growth in aquatic systems but if scarce can limit or control plant productivity. The physical processes of nitrogen cycling are settling and re suspension, diffusion, plant translocation, litter fall, sorption and ammonia volatilization (Kadlec and Wallace, 2009). The five principal processes for nitrogen transformations in a wetland are (Kadlec and Wallace, 2009):
Ammonization;
Nitrification;
DE nitrification;
Assimilation; and
Decomposition.

There are some processes that affect in removal or retention of nitrogen in constructed wetlands from wastewater: NH3 volatilization, nitrification, DE nitrification, nitrogen fixation, plant and microbial uptake, mineralization (ammonification), nitrate reduction to ammonium (nitrate-ammonification), anaerobic ammonia oxidation (ANAMMOX), fragmentation, sorption, desorption, burial, and leaching.

3. Nitrogen removal from agricultural runoff via constructed wetlands

Nitrogenous and phosphorus compounds in agricultural runoff are important factors that causing eutrophication in water bodies; thus, it is important to control N levels from such sources. Therefore, removal or treatment of two nutrients before entering water bodies is essential. The nitrogen entering wetland systems can be measured as organic nitrogen, ammonia, nitrate and nitrite. Total Nitrogen refers to all nitrogen species. The removal

* Corresponding Author.

of nitrogen from wastewater is important because of ammonia's toxicity to fish if discharged into water courses.

Table 1: Nitrogen transformations in (constructed) wetlands (Vymazal, 2007)

Process	Transformation
Volatilization	ammonia-N (aq) → ammonia-N (g)
Ammonification	organic-N → ammonia-N
Nitrification	ammonia-N → nitrite-N → nitrate-N
Nitrate-ammonification	nitrate-N → ammonia-N
Denitrification	nitrate-N → nitrite-N → gaseous N_2, N_2O
N_2 Fixation	gaseous N_2 → ammonia-N (organic-N)
Plant/microbial uptake (assimilation)	ammonia-, nitrite-, nitrate-N → organic-N
Ammonia adsorption	
Organic nitrogen burial	
ANAMMOX (anaerobic ammonia oxidaton)	ammonia-N → gaseous N_2

Excessive levels of nitrates in drinking water are thought to cause methemoglobinemia in infants, which decreases the oxygen transport ability of the blood. In a review of 19 surface flow wetlands (US EPA, 1988) it was found that nearly all reduced total nitrogen. In a review of both surface flow and subsurface flow wetlands, Reed (1995) concluded that effluent nitrate concentration is dependent on maintaining anoxic conditions within the wetland so that DE nitrification can occur. He found that subsurface flow wetlands were superior to surface flow wetlands for nitrate removal. The 20 surface flow wetlands reviewed reported effluent nitrate levels below 5 mg/L; the 12 subsurface flow wetlands reviewed reported effluent nitrate ranging from <1 to < 10 mg/L.

Borin and Tocchetto (2007) reported the 5-year performance of a constructed surface-flow wetland in reducing diffuse N pollution coming from croplands, begun in 1998 in NE Italy. The 0.32-ha wetland is vegetated with Phragmites australis (Cav.) Trin. and Typha latifolia (L.). A summary of the effectiveness of constructed wetlands to removal nitrogen from agricultural runoff for various studies is presented in Table 4 (the references upon which the range is based are given in the right column). Shaoyong et al. (2009) were studied the nitrogen distribution pathways, and the nitrogen species removal kinetics, of a free water surface constructed wetland (2,800 m2) in the Dianchi Valley, which has been in operation for 27 months. Results showed HRT had negative correction with both TN and ammonia removal, and the nitrate removal efficiency and parameters mentioned earlier were not significantly correlated.

Table 2:

Region	Effectivenes Range	References
	>50%	Brix, 1994
China	10–24 % (in 3 phase)	Lee et al, 2004
China	66.1 %	Wang, et al, 2004
Illinois, USA	37%	Kovacic et al, 2000
Murcia, Spain	88.2%	Garcia et al., 2009
southern Quebec, Canada	19 %	Kroeger et al, 2007
Iran, Khuzestan	17.3 – 53.7	Afrous et al, 2012
Mean of some of countries	41.2 – 54.8	Vymazal, 2007

4. **Conclusion**

Globally, irrigation and fertilization of agricultural lands is placing increasing pressure on water quality and availability. Dissolved nitrogen is lost from fields primarily as dissolved nitrate due to its highly soluble nature. It can be leached out through subsurface drains or overland as surface runoff. Constructed wetlands are an interesting way for targeting nutrient reduction nitrogen from agricultural runoff because the concept can be implemented in many different situations and built with materials available locally.

References

Afrous, A., Liaghat, A., 2012. Reducing nitrogen and phosphorus from agricultural drainage using constructed wetland systems and open drains. Protection of soil and water (in Persian), Vol. 1(4): 74-86.

Borin, M. & D. Tocchetto, 2007. Five year water and nitrogen balance for a constructed surface flow wetland treating agricultural drainage waters. Science of the Total Environment 380(1–3): 38–47.

Comin, F. A., Romero, J.A., Astorga, V., Garcia, C., 1998. Nitrogen removal and cycling in restored wetlands used as filters of nutrients for agricultural runoff. Water Science and Technology, 35 (5): 255–261.

Garcia, V., Gomez, R., Vidal-Abarca, M. R., Suarez, M. L., Nitrogen retention in natural Mediterranean wetland-streams affected by agricultural runoff, Hydrol. Earth Syst. Sci., 13, 2359–2371.

Kovacic, D. A., David, M. B., Gentry, L. E., Starks, K. M., Cooke, R. A., 2000. Effectiveness of Constructed Wetlands in Reducing Nitrogen and Phosphorus Export from Agricultural Tile Drainage. Reprinted from the Joumal ofEnvironmental Quality, 29: 1262-1274.

Kroeger, A.C., Madramootoo, C. A., Enright, P., Laflamme, C., 2007. Efficiency of a small constructed wetland in southern Québec for treatment of agricultural runoff waters. Moving Forward Wastewater Biosolids Sustainability: Technical, Managerial and public synergy. June 24-27, 2007. Canada.

Lee, C., Lee, C., Lee, F., Tseng, S., Liao, C., 2004. Performance of subsurface flow constructed wetland taking pretreated swine effluent under heavy loads. Bioresource Technology 92: 173–179.

Reed, S.C. and D. Brown. 1995. Subsurface flow wetlands - a performance evaluation. Wat. Env. Res. 67:244 - 248.

Shaoyong, L., Pengyi, Z., Xiangcan, J., Meng, G., Jian, Z., Lu, Fengmin, L., 2009. Nitrogen removal from agricultural runoff by full-scale constructed wetland in China. Hydrobiologia Journal, 621: 115-126.

Vymazal, J., 2007. Removal of nutrients in various types of constructed wetlands. Science of the Total Environment 380, 48–65.

Wang, X.H., Yin, C.Q., Shan, B.Q., 2005. The role of diversified landscape buffer structures for water quality improvement in an agricultural watershed, North China. Agriculture, Ecosystems and Environment 107: 381–396.