INTEGRATED CONSTRUCTED WETLANDS TO TACKLE DIFFUSE NITRATE CONTAMINATION IN SURFACE WATER

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Introduction

The European Union statistical office, Eurostat, revealed in 2012 that amongst the members of the EU, Belgium was the first on the list of countries with higher nitrate concentrations in groundwater. The Flemish Environmental Agency (VMM) reported in 2013 that 26% of the monitoring stations located in small fresh watercourses in Flanders are still exceeding the maximum allowable limit of 50 mg NO_3^-/l. Regarding the key aims of the Water Framework Directive: to achieve "a good status" of all waters by 2027 and to develop water management plans per river basin, we investigate whether eco-engineering and installing Constructed Wetlands (CWs) at selected locations alongside small fresh watercourses could help to diminish diffuse nitrate contamination.

Objectives

- Examine the effect of the surface flow of watercourses and the environmental conditions in the surface area needed for implementing integrated constructed wetlands (ICW).
- Highlight the flaws in the determination of main parameters to consider, prior the installation of CWs.

Methodology

1. Site selection: Broenbeek – Stadendrevebeek watercourse, part of the IJzer basin. West Flanders province of Belgium.
2. Analysis of monthly NO_3^- concentrations registered by the VMM between November 2002 till November 2015 and determination of exceeding values above the 50 mgNO_3/l.
3. Estimation of surface areas needed for implementing CWs able to decrease peak concentrations. Theoretical nitrate removal rates achieved in full scale CWs systems at similar weather conditions than Belgium were considered.

$$A = \frac{(Q_{in} * C_{in}) - (Q_{out} * C_e)}{k}$$

Where:
A = treatment area of the wetland (m^2 or ha)
$\mathbf{Q_{in}}$ = flow rate incoming in the wetland (m^3/day)
$\mathbf{Q_{out}}$ = flow rate outgoing from the wetland (m^3/day)
$\mathbf{C_{in}}$ = influent concentration (mg NO_3/l)
$\mathbf{C_e}$ = target effluent concentration (mg NO_3/l)
k = nitrate removal rate (g NO_3/m^2.d)

Results

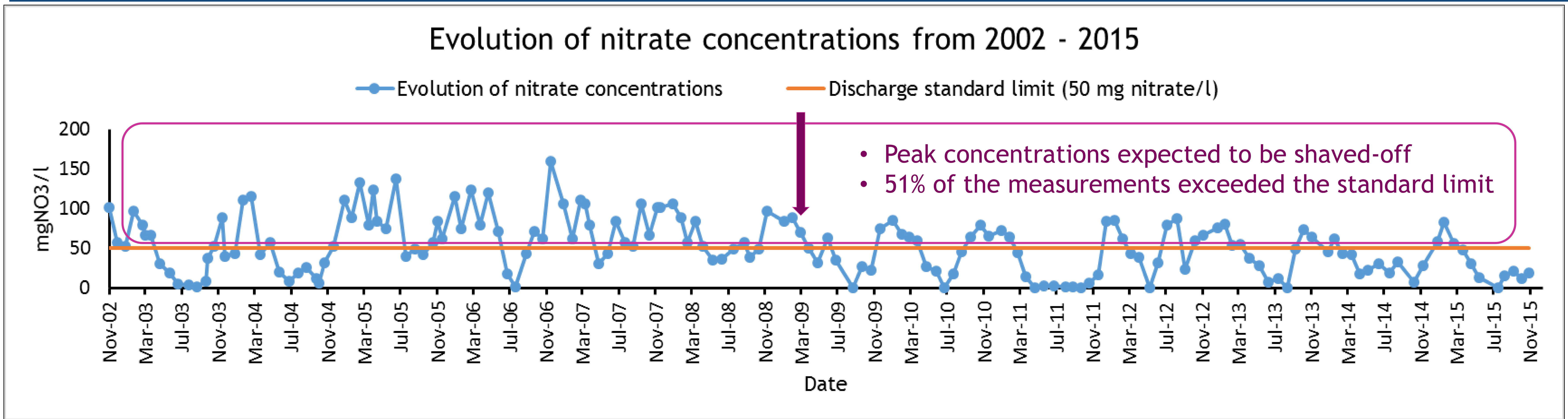

Table 1: Surface area needed at different experimental nitrate removal rates.

Year	Highest NO_3^- conc. registered in the Broenbeek – Stadendrevebeek	Average surface flow (m^3/d) 13824			
		Experimental nitrate removal rates (g NO_3/m^2.d)			
		0.2	0.3	0.5	0.6
		Surface area			
	mg/l	ha	ha	ha	ha
2003	97.4	27.0	18.7	14.1	10.4
2005	137.2	49.7	34.5	26.0	19.1
2007	110.6	34.5	24.0	18.1	13.3
2009	88.5	21.9	15.2	11.5	8.5
2011	72.6	12.9	8.9	6.7	5.0
2013	**81.0**	17.7	**12.2**	**9.2**	6.8
2015	**82.3**	18.4	**12.8**	**9.6**	7.1

5 ha	5 to 10 ha	10 to 15 ha	> 15 ha

- Decrease tendency of the highest concentrations recorded in the past 5 years.
- Intense agricultural activities in small water represent elevated water use and evapotranspiration rates. The Probability Distributed Moisture (PDM) model used to determine the average surface flow does not consider these parameters. Hence, the 13824 m^3/d could be overestimated.
- Land required would be around 9 to 13 ha in order to diminish the nitrate concentrations for the presented case study.

Conclusions

- In the current investigation relatively high surface flow and low nitrate removal rates would increase the surface area needed for the implementation of CWs. A better understanding of these controlling factors as well as the hydrology of small waterways influenced by intense agriculture, should lead to an appropriate definition of the area and number of CWs needed to decrease nitrate concentrations. Insight flow dynamics of small watercourses would compensate the possible overestimation of the wetland size.
- ICWs offer an interesting perspective to tackle diffuse nitrate pollution, hence, the importance to further explore the feasibility of the presented study.

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