EFFECT OF NUTRIENT DYNAMICS ON ORGANIC CONTAMINANT FATE IN RIVERS: A MICROCOSM STUDY

Tolessa Deksissa and Peter A. Vanrolleghem

Department of Applied Mathematics, Biometrics and Process Control (BIOMATH), Ghent University, Coupure Links 653, B-9000 Gent (Belgium)

OBJECTIVES

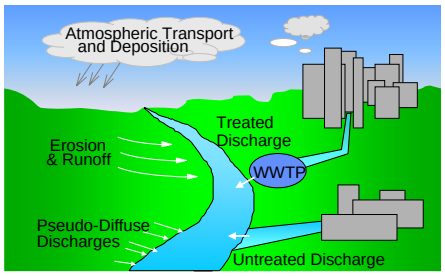
Though the effect of nutrient and toxic organic contaminants in rivers interact in many different ways, coupling of these two problems in a traditional river water quality modelling was ignored. Recently an integrated exposure model that takes into account the effect of nutrient dynamics on the fate of organic contaminants was developed [1].

The aim of this study is to experimentaly investigate the effect of nutrient dynamics on the fate of organic contaminants in rivers so that the data can be used to validate/refine the integrated exposure model.

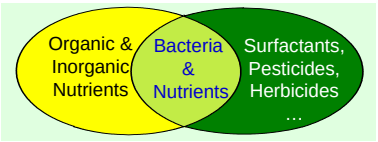
MATERIALS AND METHODS

Conceptual

⇒ Source of pollutions

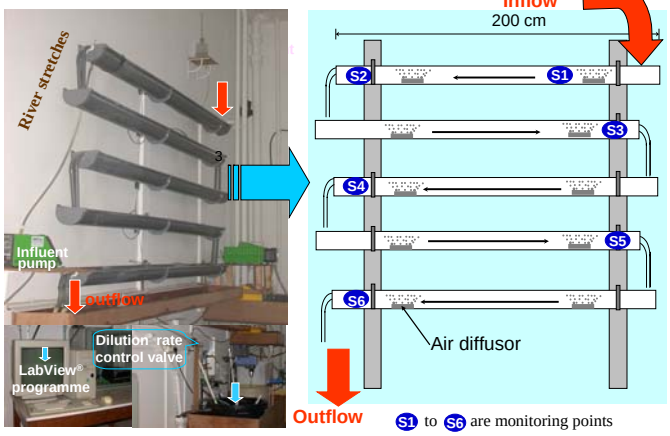


⇒ linking variables in the removal processes of pollutants: interaction



Experimental

⇒ Artificial river set-up



S1 to S6 are monitoring points

⇒ Monitoring

Water quality variables	Analytical methods
• Linear alkylbenzenesulphonate (LAS)	Azure A [2]
• Dissolved Oxygen (DO)	DO electrode
• NH_4-N, NO_3-N	Dr. Lange analysis kits
• Total suspended solids (TSS) & benthic biofilm biomass	Dry weight (24 hour at 105 °C)

RESULTS AND DISCUSSION

The effect of biofilm, aeration, and external load of substrates (Chemical Oxygen demand (COD) and NH_4-N on the in-stream fate of LAS was investigated.

- LAS degrades faster in the presence of biofilm than when there is only suspended microbial biomass (see Figure 1(a))
- LAS accumulates when the river stretches are not aerated because LAS degrades only in oxic conditions (see Figure 1(b)).

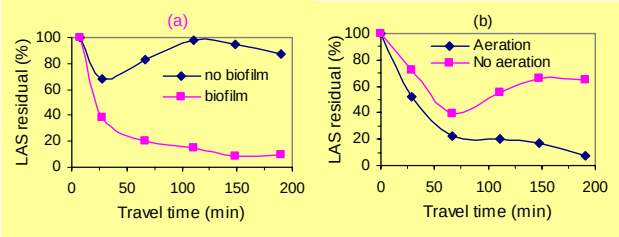


Figure 1: The effect of biofilm (a) and aeration (b) on LAS degradation

- External NH_4-N load resulted in a very rapid LAS biodegradation (immediate uptake) (Figure 2(a)). This was due to very low NH_4-N concentration in the river water prior to the external nutrient load, regardless of high NO_3-N that can potentially be used as an alternative nitrogen source for the growth of heterotrophs.
- A low external COD load enhanced the LAS biodegradation, whereas high COD load retards aerobic biodegradation by depleting DO (Figure 2 (b)). When a higher COD load is combined with no aeration (see 0.375++ in Figure 2 (b)), more significant ($p < 0.05$) LAS accumulation was observed.

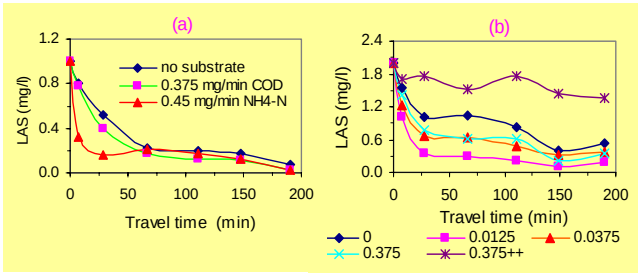


Figure 2: Effect of external NH_4-N (a) and COD (b) load [mg/min] on the LAS degradation: 0.375++ is 0.375 mg/min COD in combination with no-aeration

TAKE HOME MESSAGE

- Including biofilm processes in the organic contaminant fate model in rivers is very important, especially in shallow rivers.
- The nutrient load dynamics can affect the fate of organic contaminants, and thus including nutrients in the organic contaminant fate modelling is necessary.
- The sensitivity of LAS degradation to the ammonia nitrogen is an interesting finding and can induce further research in order to investigate the mechanism.

ACKNOWLEDGEMENT

The authors would like to thank the Belgium Technical Co-operation (BTC-CTB) for its financial support, and the Procter & Gamble for providing us the LAS product.

REFERENCES

1. Deksissa T. and Vanrolleghem P.A. (2003). Integrated modelling of eutrophication and organic contaminant fate in rivers. In: Proceedings the IWA conference on Environmental Biotechnology Advancement on Water and Wastewater Applications in the Tropics 9 – 10 December 2003, Kuala Lumpur, Malaysia. (accepted).
2. den Tonkelaar W.A.M. and Bergshoeff G. (1969). Use of azure A instead of methylene blue for determination of anionic detergents in drinking and surface waters. *Water Res.*, 3, 31-38.

tolessa@biomath.ugent.be - http://biomath.ugent.be