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The Omega-3 Index of macrophytes to improve the assessment of the treatment performance of constructed wetlands receiving treated wastewater.

M. Le Guévardi1, J.J. Bessoule2, C. Boutin3, H. Budzinski1, K. Le Menach4, M. Coquery1, N. Dhernet5, N. Forquet6, C. Miège7, S. Papias8, R. Clément9, JM. Choubert10

1 LEB Aquitaine Transfin-ADERA, Villeneuve d'Ornon, France; 2 CNRS, UMR5200 LIBM, Université de Bordeaux Villeneuve d'Ornon, France; 3 ISTEIA, UR Riviera, Villenneuve Cedex, France; 4 CNRS, UMR 5805 EPDC, Université de Bordeaux, Talence, France; 5 ISTEIA, UR REVEGAAL, Villenneuve Cedex, France

Introduction

Effluents from wastewater treatment plants (WWTP) contain chemicals that are not removed (metals, pharmaceuticals, hormones...) and are therefore considered as a source of pollution for the aquatic environment. Constructed wetlands receiving treated wastewater (CWtw), built between the WWTP and the receiving environment, can help to limit the impact of WWTP discharge on the natural environment. The commonly used methods to evaluate the treatment performance of these processes are mainly based on physicochemical parameters. However, the wide variety of contaminants that can be encountered and their variable concentrations over time (sometimes below the limit of detection of equipments) constitute a limit of the use of such tools. Moreover, these methods do not provide information on the toxic impact of the treated water on the recipient ecosystem that is one expectation of the WFD. Plants respond to environmental changes and exhibit signs of stress in polluted conditions. They reflect the impact of the overall toxic contaminants on the ecosystem and by this can fill the gap left by physicochemical analyses concerning the toxic impact of environmental realistic contaminant mixture on ecosystem.

The Omega-3 Index, a standardized biological tool based on plant stress response, has been proven it worth to assess soil quality (ISO/FDIS 21479). In this study, the Omega-3 Index of Reed leaves was tested as a biological tool to assess the treatment performance of CWtw and, as a consequence, the improvement of water quality. This biological tool was implemented on the experimental sites of the MARQUERITTES and BIOTRITYS projects located in the suburb of Nîmes and Bordeaux metropolises. These projects aimed at studying the operations and the true effectiveness for the removal of conventional pollutants and micropollutants of CWtw with different configurations (ponds, meadows, ditches built with soil and adsorbing materials).

Materials and methods

Leaf fatty acid composition analysis: fresh foliar tissues were placed in 1 ml of methanol containing 2.5% sulfuric acid. After 1 hour of heating at 80 °C, 0.75 ml of hexane and 1.5 ml of water were added. After vigorous shaking and centrifugation, methyl esters extracted in hexane phase (upper phase) were analysed by gas chromatography (Agilent 7890A). The percentage of each fatty acid was determined and the Omega-3 index was then calculated. The Omega-3 index decreases when the soil is polluted and gives information on the health status of plants.

First test with the Omega-3 index on a CW using reed bed filters receiving sewage from a village

Comparison of the treatment efficiency of several CWtw: BIOTRITYS project

Fig. 6. CWtw with different configurations (meadows, ditches built with soil and adsorbing materials) studied during the BIOTRITYS project

Fig. 7. Diagram of the CWtw built for the BIOTRITYS project with different configurations (meadows, ditches built with soil and adsorbing materials). Reeds leaves were harvested from upstream to downstream of each CWtw

Fig. 8. Omega-3 index measured on reeds harvested from the different CWtw

Table 1. Removal efficiency (%) of some micropollutants extracted in water (Red=30%, Orange=70%, Green=100%)

Table 2. Concentration of some micropollutants in reeds harvested upstream and downstream the pilot P2 (µg g-1)

What about CWtw?

Evaluation of the treatment efficiency of a pond CWtw: MARQUERITTES SITE

Fig. 9. Omega-3 Index measured on reeds harvested from upstream (C) and in S3 located from upstream to downstream (S1, S2, S3) after the release of treated wastewater (P1, P2, S3) in the pilot P2 before the release of the treated wastewater (C) and in S3 located from upstream to downstream (S1, S2, S3) after the release of treated wastewater

Fig. 10. Omega-3 Index measured on reeds harvested upstream and downstream of the second pond

Conclusions

All our results obtained show that plant health is positively correlated with the improvement of water quality from downstream and therefore the Omega-3 index seems to be a relevant biological tool to assess CWtw performance. From a regulatory standpoint, this bioindicator could help to better evaluate the treatment performance of CWtw and to assess the complex effects of pollutants present in this type of process in mixture and at very low concentrations. The ISO standard of this tool used in soil quality will be published very soon (ISO/FDIS 21479) and could be extended to water quality assessment.