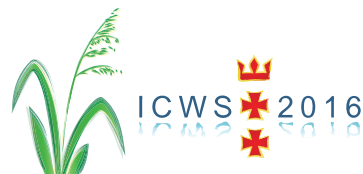


15<sup>th</sup> IWA International Conference on

# Wetland Systems for Water Pollution Control



## Conference Proceedings

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BIAŁYSTOK  
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Changing the future together



# 15th IWA International Conference on Wetland Systems for Water Pollution Control



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## Editor

Gajewska Magdalena

Matej-Lukowicz Karolina

Wojciechowska Ewa



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# Introduction



On behalf of the IWA Specialist Group members in Poland, I am honoured to welcome you to Gdańsk, Poland, for the 15<sup>th</sup> International Conference on Wetland Systems for Water Pollution Control.

Treatment wetlands, in the past more frequently called constructed wetlands, have been introduced in Poland in the late eighties of the twentieth century. An example of the first system was a facility in Frombork constructed in 1985 as a part of a natural wetland (inhabited with reed) and separated by a dike in the Vistula lagoon. In this way a natural wetland became a treatment wetland with 50% efficiency removal of organic matter for 850 m<sup>3</sup>/d of mechanically pre-treated wastewater. During the next 10 years treatment wetland technology became popular in Poland due to inexpensive costs and a low demand in technology for a variety of different wastewater treatments. Unfortunately frequently basic principles of design and operation were not been obeyed because of insufficient knowledge. In consequence most of these plants did not provide an adequate level of treatment. This resulted in a lack of confidence and trust to TWs technology as an effective method of treatment.

However, thanks to the efforts and continuous work of the Polish research groups who set themselves the goal of promoting TW technology as a means of fulfilling the principles of sustainable water management and environmental protection, this method is becoming popular again. From the beginning, Prof. Hanna Obarska-Pempkowiak was actively working locally and internationally in this field. In 2016 she will celebrate the 45<sup>th</sup> anniversary of work which was mostly devoted to the research and promotion of TW technology.

In last ten years treatment wetlands technology has gained in popularity once again. Especially as technology for domestic wastewater treatment in households located in dispersed settlements as well as in sustainable stormwater treatment and retention in urban areas.

I hope our conference provides an important platform for exchange of knowledge and ideas between scientists, engineers, environmentalists, managers, consultants, authorities, student researchers of other expert countries with the Polish stakeholder and potential counterparts. Thanks to location the event might be mirrored in across Eastern Europe and countries that border the Baltic Sea. In the aftermath I hope increase interest in the use of treatment wetland systems for water pollution control in our region of Europe.

This conference brings together about 214 delegates from 41 countries. The two volumes of proceedings include manuscripts from 6 keynote presentations, 150 oral presentations, and 63 poster presentations. The two leading topics of Keynote of 15<sup>th</sup> ICWS 2016 are applications of TWs in sustainable stormwater treatment and emerging pollutants treatments. As usual among papers submitted for conference over 30 are dealing with biogenic compounds removal (four sessions), a bit less with combined sewer overflows (three sessions), sludge reed drying beds (two sessions), plants effects (two sessions) and design tools and guidelines (two sessions), aerated wetlands (two sessions). From submitted topics two very important and relatively new trends in research are emerging (i) industrial and agricultural wastewater treatment (three sessions) and persistent organic pollutants (pharmaceuticals and pesticides) (four sessions).

I would like to acknowledge the (i) Ministry of the Environment, Marshal Office of the Pomorskie voivodship as well as Mayor of Gdansk and Rector of Gdańsk University of Technology for honorary patronage (ii) our corporate sponsors Ecol-Unicon, Retencja.pl as well as CH2M HILL. My sincere thanks goes to our Partners: LOTOS, WFOŚiGW in Gdańsk, Melioracje Gdańskie, Zoo. Very special appreciations goes to Gdańsk Water Utilities (GIWK) as main co-organizer and Warsaw University of Life Science (SGGW), Lublin University of Life Science (LULS), Białystok University of Technology (BUT) and Halmstad University. And last but certainly not least, my great thanks and appreciations to managers, friends, colleagues and employees from Gdańsk University of Technology.

*Magdalena Gajewska*

September 4, 2016

# Removal efficiency of pharmaceutical metabolite caffeine by *Vetiveria zizanioides* in a Vertical Flow Constructed Wetland VFCW

**Almeida, A.<sup>a</sup>, Calado, M.<sup>a</sup>, Catarino, A.<sup>a</sup>, Castanheira, I.<sup>a</sup>, Ribeiro, C.<sup>a</sup>,  
Carvalho, F.<sup>a</sup>, Prazeres, A.<sup>b</sup>, Chaves, H. <sup>a</sup>**

<sup>a</sup>Instituto Politécnico de Beja, Ap 158, 7801-902 Beja, Portugal; (E-mail: [maalmeida@ipbeja.pt](mailto:maalmeida@ipbeja.pt), Tel. +351284314300; Fax +351284388207).

<sup>b</sup> Centro de Biotecnologia Agrícola e Agro-Alimentar do Alentejo (CEBAL)/Ap. 6158, 780 Beja, Portugal

## Abstract

Pharmaceuticals and their metabolites have been detected worldwide in wastewater, surface water, groundwater and even in drinking water. They are now considered as emerging contaminants of environmental concern because of their widespread use, continuous release, persistence, and increasing evidence of their ecotoxicological (if not human health) effects. Since some pharmaceutical compounds are not completely removed by conventional wastewater treatment, they are ubiquitous and persistent pollutants in receiving waters worldwide, especially where municipal wastewaters are discharged into waterways. Caffeine is a purine alkaloid and one of the most widely consumed drugs in the world, is a stimulant which is found in hundreds of prescription and over-the-counter drugs, from analgesics to cold medicines. Caffeine is usually found to be persistently in water bodies, because of its high solubility (21.6 g L<sup>-1</sup>) and negligible volatility. Because conventional treatments cannot degrade caffeine efficiently, it is necessary to look for alternatives. Constructed wetlands (CWs) have been found to be a successful technology for removing pharmaceutical compounds including caffeine from wastewaters. This work aims to assess *Vetiveria zizanioides*'s ability to withstand and remove caffeine from. The research was developed in a pilot sub-surface vertical bed (VFCW) (0.4 × 0.6 × 0.70 m) planted with *Vetiveria zizanioides* on an inert matrix of light expanded clay aggregates. The VFCW was continuously fed with synthetic wastewater supply with a mineral medium and caffeine.

The hydraulic load ( $H_L$ ) was kept constant at  $90 \pm 4 \text{ L/m}^2\text{d}$ . Water samples were collected from the influent and effluent of the bed. The pH, electrical conductivity of (EC), redox potential (Eh) and dissolved oxygen (DO) were measured. The concentration of caffeine was determined by HPLC-MS-MS. Photosynthetic pigments were extracted and calculated. Three increasing caffeine concentrations of  $110 \pm 2 \mu\text{g L}^{-1}$ ,  $202 \pm 1$  and  $301 \pm 1 \mu\text{g L}^{-1}$  were used in this study. On average, the influent had a pH of  $7.9 \pm 0.23$ , EC  $970 \pm 190 \text{ mScm}^{-1}$ , Eh  $168 \pm 27 \text{ mV}$ , and dissolved oxygen (DO)  $11 \pm 0.6 \text{ mgO}_2\text{L}^{-1}$ .

High removal efficiencies were attained to caffeine from  $99.5 \pm 0.01 \%$  to  $89.5 \pm 0.01 \%$  after a retention time of only  $6.23 \pm 0.23$  hours. Exposure to higher caffeine concentrations did not affect *Vetiveria zizanioides*'s photosynthetic pigments but, by the end of the assays, a stop in plant growth was observed; it is not clear if this growth stop was caused by caffeine or due to the vegetative cycle. Further work is needed to determine if the *Vetiveria zizanioides* physiology is affected or not by high concentrations of caffeine. It must be stressed that this study points out to this low-cost technology be applicable for treatment of wastewaters contaminated with pharmaceuticals.