

Water quality improvement in a tertiary created wetland: effects on conventional and specific organic contaminants

Esther Llorens^a, Victor Matamoros^b, Virginia Domingo^c, Josep M. Bayona^b and Joan García^a

^aHydraulics, Coastal and Environmental Engineering Department, Technical University of Catalonia, Jordi Girona 1-3, Mòdul D-1, 08034 Barcelona, SPAIN (e.llorens@upc.edu, joan.garcia@upc.edu)

^cEnvironmental Chemistry Department, IIQAB-CSIC, Jordi Girona 18, 08034 Barcelona, SPAIN (vmmqam@cid.csic.es; jbtqam@cid.csic.es).

^bEnvironment Department, Town Hall of the City of Granollers, Sant Josep 7, 08400 Granollers, SPAIN (vdomingo@ajuntament.granollers.org)

INTRODUCTION

During the last centuries most of the natural wetlands of the Mediterranean area were drained and dried up in order to reduce the risk of infectious diseases dissemination and to convert these zones in agricultural land. In addition, a great number of wetlands also disappeared during the second half of the XX Century as a result of the tourist boom in Mediterranean coastal resorts. In view of these environmental “losses”, nowadays there is a growing interest in the area for environmental restoration of wetlands. The use of reclaimed water constitutes an opportunity for wetland creation and restoration in a context, as the Mediterranean, in which water shortages and scarcity have rose in the last decades.

The surface flow constructed wetland (SF CW) created in the periurban park of Can Cabanyes (Granollers, Northeastern of Spain) constitutes part of a series of activities that have served for restoring a fluvial environment highly impacted. The park is located in the metropolitan area of Barcelona (4 million people), and surrounded by a highway, an old landfill, a large wastewater treatment plant, a solid waste treatment plant and an important circuit of careers. This paper describes the benefits of the SF CW in improving the water quality, which in the future will be reused for agricultural irrigation. In addition to conventional water contaminants (i.e TTS and COD), pharmaceuticals and personal care products (PPCPs) have been taken in to account in this study. Compounds selected include a large class of chemicals originated from human usage (analgesics, antiepileptic, antilipidics and fragrances).

METHODS

The SF CW is constituted by a single cell with a surface area of 1 ha, with shallow zones (0.3 to 0.4 m of water depth) planted with *Typha* and *Phragmites*, unplanted deep zones (1.5 m) and with a small island. These different zones were created in order to increase the ecological variability of the system. The system started operation in April 2003.

The SF CW is fed with a small part of the treated effluents of Granollers urban wastewater treatment plant, that does not nitrify and that receives industrial discharges. The wetland received approximately 100 m³ day⁻¹ since April 2006 because the effluents of the treatment plant have a high concentration of ammonia (approximately 30 mg N/L) and the system was designed to reach an ammonia concentration lower than 2 mg N/L. From April 2006 the flow was increased to approximately 250 m³ day⁻¹ in order to increase the available water resources because the future plans of reuse for agricultural irrigation and to check the efficiency of the wetland under these new conditions.

Effluents of the wetland were monitored from 2003 to 2006 by means of biweekly samples for physico-chemical parameters and weekly samples for faecal bacterial indicators.

Effluent TSS, COD, ammonia and faecal bacteria were analysed from grab samples using standard methods. Influent data were provided from the managers of the Granollers wastewater treatment plant. Moreover, PPCPs were measured in the influent and effluent during two sampling campaigns (June 2005 and February 2006) of five consecutive days each one.

RESULTS AND DISCUSSION

The influent of the wetland (which is the effluent of the wastewater treatment plant) is rather constant in terms of quality with mean concentrations of 35 mg L⁻¹ for TSS, 150 mg L⁻¹ for COD, 30 mgN L⁻¹ for ammonium and 3.5 ulog 100 mL⁻¹ for faecal coliforms. In the first year of operation (2003) the effluents of the wetland were of poor quality with average TSS and COD concentrations even higher than the respective influent concentrations (Table 1). Also ammonium effluent concentrations were quite high indicating that the system had a low nitrification capacity. These high average effluent concentrations for all parameters evaluated were mostly due to extremely high concentrations that were only observed during the start up (April to June 2003).

From 2004, when the vegetation was well developed, the quality of the effluents improved progressively in terms of TSS, COD and ammonium. Even when the flow was increased in 2006 (from 100 to 250 m³ day⁻¹) TSS and COD concentrations slightly decrease. Ammonium concentration increased in 2006 in connection with the raise in the flow. Effluent microbial quality has been of quite good quality since the start up of the system.

Table 1. Averages and SD (in brackets) of the main water quality parameters in the effluents of the surface flow constructed wetland located in the park of Can Cabanyes (Granollers, Spain). n = 20-50 depending on the year and the parameter.

Year	TSS (mg L ⁻¹)	COD (mg L ⁻¹)	Ammonium (mgN L ⁻¹)	Faecal coliforms (ulog 100mL ⁻¹)
2003	151 (202)	263 (245)	21 (16)	1.9 (0.9)
2004	57 (62)	85 (42)	4.6 (5.2)	1.5 (0.7)
2005	35 (26)	82 (26)	5.3 (6.8)	1.4 (0.8)
2006	21 (17)	59 (17)	11 (14)	1.5 (0.7)

Effluent ammonium concentration follows an interesting seasonal pattern that has not been observed for the other parameters studied (Figure 1). In a systematically way ammonium concentration increases during the cold months and has very low values during the warm ones (< 1 mg L⁻¹). This trend clearly shows the temperature dependence of mechanisms involved in ammonium removal (i.e. nitrification and plant uptake).

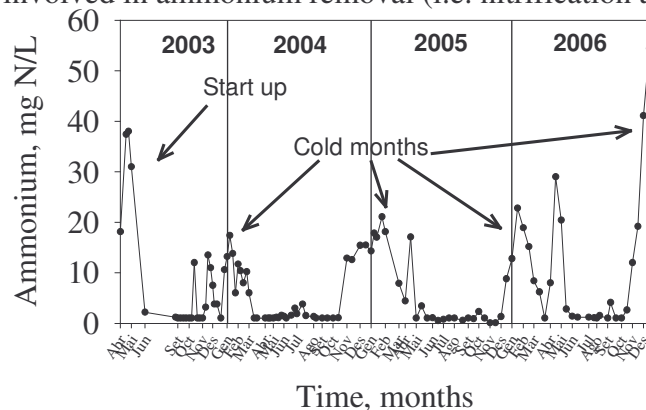


Figure 1. Changes in time of effluent ammonium concentration of the surface flow constructed wetland located in the park of Can Cabanyes (Granollers, Spain).

In addition, PPCPs concentrations analysed in the influent were in the range of ppb to ppt, which is consistent with a tertiary effluent. High removal efficiencies were achieved for all the PPCPs except for carbamazepine and clofibric acid, which exhibited a more refractory behaviour (removal efficiencies: 20-30%).

CONCLUSION

The created wetland has good performance for removing conventional and specific organic contaminants.