

PRESENCE OF EMERGING CONTAMINANTS, PRIORITY SUBSTANCES AND HEAVY METALS IN TREATED WASTEWATER AND GROUNDWATER IN THE LLOBREGAT DELTA AREA (BARCELONA, SPAIN).

Teijón, Gloria; Tamoh, Karim; Candela, Lucila

Dep of Geotechnical Engineering and Geoscience–UPC. Gran Capitán s.n. 08034–Barcelona (Spain).

gloria.teijon@upc.edu, karim.tamoh@upc.edu, lucila.candela@upc.edu

Abstract

Initial sampling results of emerging contaminants at the Llobregat delta deep aquifer (Barcelona, Spain) are presented. Among micro contaminants selected are 82 pharmaceuticals (antibiotics, lipid regulation agents, analgesic/anti-inflammatory drugs, etc), 18 personal care products (sunscreen agents, preservatives and disinfectants/antiseptics), 4 metals, 44 pesticides, 6 volatile priority pollutants, 16 PAHS and dioxins. Monitoring programme consisted on periodical water sampling from municipal wastewater tertiary treatment plant (WWTP), tertiary water with additional treatment being injected in the aquifer and from the aquifer. With regard to the emerging contaminants, the applied treatment has demonstrated its effectiveness for the removal of this type of microcontaminants

Keywords: Emerging contaminants, Reclaimed water, Groundwater, Llobregat Delta.

Introduction

In the Barcelona metropolitan area, water is a limited resource and of great importance due to the presence of an extended industrial activity and water supply demand. In order to reduce this deficit, wastewater reuse from the Depurbaix sewage treatment plant (Cazurra, 2006), located in the Baix Llobregat is intended, thus contributing to the sustainable management of water. The volume of water to be reused is destined to satisfy different demands such as the contribution to ecological flow, agricultural irrigation, maintenance of wetlands and the construction of a hydraulic barrier against the existing sea water intrusion in the Llobregat river delta deep aquifer.

The objective of the research was to investigate the occurrence of 170 emerging contaminants of different group classes (Daughton and Turner, 1999; Sedlak et al., 2000, Daughton, 2004), priority substances (2008/105/EC) and heavy metals from treated municipal wastewater for a seawater intrusion hydraulic barrier injection and the Llobregat deep aquifer.

Study site

The Llobregat study area, located southwest of the city of Barcelona (Spain) is a delta formation covering 97 km² formed by Quaternary material deposits of a detritic nature. This delta is characterised by two coastal aquifers, upper and lower, which are separated by a silt wedge confining the lower aquifer. Both aquifers constitute a strategic resource to guarantee supply and have been studied and monitored since the 1960s (Custodio, 1981; Candela et al., 1988; Íribar et al., 1997; Abarca et al., 2006; Gámez 2007; Solá 2009). The lower aquifer occupies almost the entire delta surface, and since the 1970's it has been highly exploited producing a general lowering of the water table leading to presence of sea water intrusion in different parts of the aquifer. As a result, a progressive deterioration in the groundwater quality has been observed, reducing the possibilities of exploiting the aquifer.

In 2006, the first phase for the construction of a hydraulic barrier to control seawater intrusion was initiated (Cazurra, 2006; Ortuño Gobern et al., 2008). The hydraulic barrier scheme consists of injecting municipal treated water through wells (P1 to P4) to conform a pressure ridge along the coast, therefore stopping the seawater from entering the aquifer. In March 2007 water injection started at P3 and P4 and later in P2 (July, 2007). Only P1, P2 and P3 are currently under recharge operation. The injected water for the hydraulic barrier initially consisted of an equal mixture between treated wastewater and tap water, being replaced by only recycled water in March, 2008. The injected treated wastewater consists of outflow water from the Depurbaix tertiary sewage treatment plant that receives an additional treatment of ultra filtration, reverse osmosis and UV disinfection before being stored in a deposit for further injection in wells.

Methodology

Water samples of the influent and effluent of the tertiary treatment were taken, along with the injection water and groundwater from the local network (1 km radius around injection wells). Monitoring started in March 2007 and except for the tertiary treatment (monthly) sampling was carried out every second month by the Comunitat d'Usuaris d'Aigües del Delta del Llobregat (CUADLL), Agencia Catalana del l'Aigua (ACA) and UPC. A total of 103 water samples were analysed in a period of 21 months.

For the emerging contaminants and priority substances, 170 substances between which drugs, personal hygiene products, volatile metals, priority polluting agents, polycyclic aromatic hydrocarbons and other priority polluting agents have been selected (Teijón et al, 2010).

Results and discussion

Pharmaceuticals constitute the most detected group in all type of waters, frequency and concentration, and after tertiary treatment concentration is still high. Caffeine, Nicotine and Galaxolide

(musk fragrance) each being nonprescription drugs, were found to be present in more than 60% of the analysed samples.

Diuretics, blood lipid regulators, betablockers, analgesics, antibiotics and a fragrance are the compounds with the highest values detected in tertiary samples. After the tertiary treatment a significant reduction in concentration is observed for all compounds, and after the additional treatment, the majority of analytes concentration is reduced below 0.1 µg/L. Only 8 compounds, out of 100 monitored, were still at concentrations higher than the threshold limit.

Presence of compounds in groundwater samples was in the range of ng/L. Being the most commonly detected pharmaceuticals, stimulants, anaesthetics, diuretics, antibiotics, and analgesics. Five compounds detected at least in one sample in groundwater were not found in the treated water samples, and its presence maybe related to natural recharge from boundary areas or southern part of the river valley connected to the delta formations.

Concerning all priority substances of the EC list, only Diuron (pesticide) was detected in all types of waters with the greatest frequency at a concentration greater than 0.1 µg/L. For the selected heavy metals, Cd, Hg, Ni and Pb, (2008/105/EC), only Cd and Ni were above the maximum allowable concentration according to the directive.

Conclusion

Findings of the study indicate that not all active compounds monitored and consumed will end up in the environment. Pharmaceuticals were the class most commonly detected in all sampled waters; caffeine and Nicotine, were found at similar frequencies in all types of waters. Their ubiquitous presence maybe linked to abundant use and inefficient removal. Pharmaceuticals and PPCs only detected in groundwater samples are indicative of the presence of non treated or insufficiently treated wastewater effluents in the recharge area of the aquifer, or disposal in the aquatic system through toilets, or wastes.

The study revealed that while a small number of compounds were efficiently removed after tertiary treatment, some compounds have still been detected after the additional treatment, although concentrations were generally found to be much lower and below therapeutic doses.

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