The transport of three emerging pollutants through an agricultural soil irrigated with untreated wastewater

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ABSTRACT

The aim of this work was to determine the mobility of naproxen, carbamazepine, and triclosan through a wastewater-irrigated agricultural soil. Transport experiments were carried out using undisturbed soil columns taken at 10 and 40 cm depths. The mobilization of the pollutants was evaluated using two hydrological regimes transient flow for superficial columns and steady-state conditions for the sub-superficial columns. Results demonstrated that preferential flows are present in the superficial soil, and transient flow conditions facilitate the movement of the pollutants through the soil. Conversely, displacement of the contaminants in the sub-superficial soil columns was slower than that observed in the superficial soil. Triclosan was not found in the leachates of the soil columns at the two depths, indicating the strong retention of the compound by the soils. Conversely, naproxen and carbamazepine were determined in leachates of the soil columns at both depths. Retardation in the transport of carbamazepine was higher than that observed for naproxen in the two tested soils. Naproxen and triclosan showed some degree of dissipation, while carbamazepine was recalcitrant. It was concluded that the natural depuration system studied is capable of retaining and removing the studied pollutants and thus the risk of groundwater pollution is minimized.

Key words | pharmaceuticals, solute transport, sorption, undisturbed soil columns, wastewater reuse

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INTRODUCTION

Wastewater reuse for agricultural irrigation is a practice gaining popularity worldwide, notably in developing countries where, due to the scarcity of treatment facilities, untreated wastewater is frequently used (Jiménez & Asano 2008). In the near future, an increment is expected in the volume of wastewater reused for agricultural irrigation because: (1) it represents an easy and cheap way to dispose of wastewater; (2) it is an option to relieve water stress in arid and semiarid zones; and (3) wastewater is a source of nutrients for the receiving soils, increasing crop yields and thus the profits of farmers (Jiménez 2006). However, wastewater reuse can spoil the quality of surface and subterranean water sources in and nearby the irrigated area. It is well known that wastewater is the main route of so-called emerging pollutants to enter into the environment. These pollutants are residues of substances used in everyday consumer products, such as pharmaceuticals, personal care products, flame retardants, plasticizers, additives, etc. (Petrovic *et al*. 2008). Conventional wastewater treatment systems have demonstrated the partial removal most emerging pollutants, and thus a fraction of the original compound along with a group of its by-products are released into the environment (Ratola *et al*. 2012). Despite emerging pollutants being present in water bodies at trace levels (concentrations are reported in the range of ng/L to μg/L), their occurrence is related to endocrine disruption effects as well as to systemic damage in vulnerable organisms (Naidoo *et al*. 2009; Brausch & Rand 2011; Vandenberg *et al*. 2012).

doi: 10.2166/wrd.2013.003