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Use of geotextiles to regulate flow and reduce pollutant transfer in stormwater management

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Abstract

This paper aims at presenting an ensemble of laboratory studies that were performed in two laboratories of the French ministry of public works. The impact of geotextiles on flow and pollutant transfer (reactive solutes but also colloidal particles) was investigated at the laboratory scale. Leaching column experiments were performed to proceed to the successive injection of non reactive solutes to characterize flow processes, of heavy metals as reactive solutes and of latex particles as colloids. The transfers were investigated under several kind of hydric conditions (saturated versus unsaturated) and through several kind of porous media (calcareous deposit, sandy soil and porous gravel). Numerical modeling helped in understanding the geotextile effect on flow and pollutant transfer. All results point at the following assumptions. The geotextiles do not directly remove pollutants or colloids. They help in homogenizing flow through cutting preferential pathways. Through their influence on flow, they improve the contact between pollutants and the reactive matrix and increase the contact time between particles and pollutants. They can be considered as a potential tool for the optimization of pollutant removal in stormwater treatment plants.

Keywords: geotextiles, heavy metals, colloids, flow homogenization.

1. INTRODUCTION

Water quality must be protected insofar as water is used for many goals: supply for drinking water, irrigation, industry, etc. Yet, the climatic change is predicted to drastically impact the water cycle and then reduce the water resource, which implies a proper management of its quality. The spectrum of chemical substances that are released by human activities and can constitute a risk for the groundwater quality is large. In particular, in urban area, runoff waters carry significant loads of pollutants, including heavy metals, hydrocarbons, pesticides, bacteria and nutrients. Such a risk must be taken into account for the specific case of runoff and stormwater infiltration in infiltrations basins. The collection of runoff water and stormwater over wide areas and their injection over small areas may lead to high concentrations of pollutants (especially, hydrocarbons and heavy metals under solute and particulate forms) and threaten the quality of the underground and the groundwater [1]. There is a need for optimization of the monitoring of infiltration basins to prevent any degradation of the groundwater and the underground.

Certain infiltration basins have been designed with geotextiles. These are thin fibrous polymeric materials widely used in geotechnics for the following main environmental and hydraulic applications: filtration, separation, reinforcement and drainage processes [2]. There are two types of geotextiles. Woven geotextiles are manufactured using traditional weaving methods and are extensively used for reinforcement purposes [3]. Nonwoven geotextiles are manufactured by needle punching or melt bonding and are extensively used for drainage [4], filtration [5], protection [6], and separation [7]. Geotextiles used in filtration and drainage processes permit the flow of liquids, gases and fine soil particles but prevent major passage of large soil particles. The use of nonwoven geotextiles for filtration or drainage purposes instead of coarse-grained soils is very attractive in geo-environmental applications because of the relatively ease of placement and gain in space [2]. This is the reason why geotextiles are widely used in urban water management practices.

The objective of the paper is to present an ensemble of studies and experiments that demonstrates the potential effect of geotextiles on flow and pollutant transfer in the soil under several experimental conditions and for several kinds of pollutants. If this study was based on several previous studies [8, 9], it presents a