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Comparison between the intrinsic and specific vulnerability using a Diffusion Setup

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Abstract

Assessment of the protection capacity of groundwater aquifers and their vulnerability to pollutants, such as nitrate, is very crucial for an effective land and water management plan. A better evaluation of the intrinsic vulnerability could be achieved if the assessment parameters can be quantified rather than its subjective-qualitative nature. This paper summarizes a study carried out in order to determine the relationship between nitrate concentration in groundwater and seven hydrogeological parameters – represented by DRASTIC index – which can affect the nitrate content in the shallow aquifer. The amount of nitrate retarded in different soils in the area Schwalmtal/Nettetal (the northwestern part of the North Rhine Westphalia), is used to estimate the nitrate immission (nitrate amounts that will enter the aquifer after a certain land application). This study utilizes a new laboratory flow-through method to estimate seepage water prognosis of nitrate through the unsaturated zone. The setup utilizes a novel Diffusion Cell, which functions based on Emission-Transmission-Immission (ETI) concept. The Diffusion Cell was developed and used at the Department of Engineering Geology and Hydrogeology at RWTH Aachen University. A major advantage of the cell is that it simulates the real in-situ conditions. The cell also, as a column test, avoids the over-mixing occurs in the batch experiments. Furthermore, it simulates the transition area between the unsaturated and saturated zones and their natural conditions. Moreover, it is simply able to determine the total sorption capacity of the soil after reaching the stationary conditions. The preliminary results show a weak correlation between the intrinsic DRASTIC vulnerability and the spatial distribution of nitrate in the underlying aquifer. These results were expected, as none of the DRASTIC parameters represents directly any mechanisms of nitrate transport in the subsurface layers. The Diffusion cell provides an overview of nitrate movement in different soil types, as well as, transport parameters including retardation and sorption. It is planned to incorporate those parameters in the original intrinsic DRASTIC index, and hence, to produce a specific vulnerability index that represents nitrate. The Diffusion setup is currently running for different soil samples enclosed in Diffusion cells, where the results are being analyzed and ready to be integrated in DRASTIC.

Keywords: Diffusion Cell, Groundwater; Vulnerability, Nitrate; Soil; Retardation; Sorption