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A Comparison of Five Different Techniques to Measure Hydraulic Conductivity of a Riparian Soil in North Bavaria, Germany

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ABSTRACT

Soil's hydraulic conductivity, i.e. the Ks-value, is the predominant input factor when forecasting the vertical transport of contaminants through the soil or estimating the soil's flood retention capacity. Displacement of contaminants in the soil over extended periods of time can be attributed mainly to matrix flow, while flow through macropores becomes significant under untypically wet conditions, e.g. in the course of spills or rain storms. To obtain matrix conductivities for a soil the effect of macropores should be excluded. However, the Ks-values of a soil profile can scarcely be reflected solely by pedotransfer tables based on soil texture and bulk density. In a mercury-contaminated riparian soil different approaches to determine the soil's Ks-value were tested, such as, pedotransfer tables, soil core analysis, borehole permeameter measurements, particle-size distribution curve and the profile drainage method. Ks-values increased in the following order: borehole permeameter < particle-size distribution curve < pedotransfer table < profile drainage < soil core. The profile drainage method yielded Ks-values of matrix flow, which additionally reflected the site-specific features of Ks-values as provided by the soil core measurements. Despite requiring cost- and labor-intensive field sensors the profile drainage method may provide the best representative in-situ Ks-values for the studied site.

Key Words: borehole permeameter, Gleysol, particle-size distribution curve, profile drainage method, soil core, soil hydraulic conductivity

INTRODUCTION

Representative Ks-values are of outmost importance, e.g. when quantifying the water retention capacity in the scope of land use-planning (e.g., Lehmann and Stahr, 2010) or simulating contaminant transport towards groundwater (e.g., Gerke and Köhne, 2004). However, site-representative Ks-values are difficult to obtain (Bagarello and Provenzano, 1996). There are a number of conventional ways to determine the Ks-value: The common determination of hydraulic conductivity however is based on saturated soil core samples, which are percolated using the constant- or the falling-head method (e.g., Klute and Dirksen, 1986). To obtain representative values for one single soil horizon the Working Committee of the Federal Geological Survey requires at least 10 parallel samples (Geological Survey of North Rhine-Westphalia, 2012). This replicate sampling shall consider the spatial heterogeneity of soil