Comparing the parameters from pedotransfer functions and *in situ* permeability tests in the vadose zone of the Ogosta River floodplain in connection with validation procedures of contaminant migration modelling

Съпоставяне на параметри от педотрансферни функции и полеви инфилтрационни тестове в ненаситената част от заливната тераса на р. Огоста във връзка с валидиране на модели за миграцията на замърсители

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Абстракт. Представят се резултати за коефициента на филтрация K_{sat} на 9 почвени слоя, получени чрез използване на статистически функции за трансформиране на почвени данни и резултати за K_{sat} от полеви инфилтрационни тестове за същите разновидности. Отчита се съвпадане и съпоставимост на получените по двата метода стойности, което дава възможност за валидиране на модели на миграцията на арсена на по-голяма територия.

Key words: vadose zone, constant head permeameter, hydraulic conductivity, ROSETTA, validation procedure.

Introduction

The former mining and ore-processing activities in the upper valley of the Ogosta River have caused widespread environmental contamination with arsenic and heavy metals in the region. In order to assess and forecast the groundwater pollution, a series of models within the vadose zone of the floodplain of the Ogosta River should be performed. The partial differential equation of Richards, which describes the water flow in variably saturated porous medium, is often comprehensively represented by means of the Van Genuchten-Mualem model. Its resolving requires the knowledge of two nonlinear functions, namely the *soil water retention curve* and the *hydraulic conductivity function* (Van Genuchten, 1980). Hence, the parameters that describe those functions, especially the saturated hydraulic conductivity, are key input data in numerical models of the vadose zone processes. These parameters may be either measured directly or estimated indirectly through prediction from more easily measured data based upon quasi-empirical models. Models like this are often called *pedotransfer functions* (PTFs) because they translate basic soil data into hydraulic properties (Schaap et al., 2001). Even there are a lot of data concerning the parameterization of the unsaturated zone; due to the great soil heterogeneity some particular soil profile investigations should be performed in order to receive a realistic and reliable evaluation of the processes. In this work the authors present the results of permeability test measurements of the hydraulic conductivity and their comparison with the respective values defined by PTFs analyses as a case study of validation procedure in connection with further arsenic migration modelling.

Methodology of the investigations

In order to determine *in situ* the hydraulic conductivity, a constant head infiltration tests were performed with a compact permeameter device (Philip, 1985; Amoozegar, 1989). During the excavation work, the disturbed samples from the layers subject to *in situ* tests were collected followed by the respective particle-size distribution (PSD) analyses. Sieve and sedimentation (hydrometer) techniques as well as pycnometer method were used in order to plot out the PSD curves. Then the determined sand, silt and clay percentages were implemented into the ROSETTA code. The latter is a computer program to estimate unsaturated hydraulic properties, resp. the parameters describing them, and namely the saturated hydraulic conductivity, residual and saturated water content, and the so-called “Van Genuchten” parameters α and n. The program offers 5

Table 1. Particle-size distribution percentages and hydraulic conductivity values (K_{sat}) determined by both the pedotransfer function analyses and constant head permeability tests

Point	Depth	Particle size distribution ranges, % (USDA)			K_{sat}	K_{sat}*
		sand	silt	clay		
No	cm	2–0.05 mm	0.05–0.002 mm	< 0.002 mm	m s^{-1}	m s^{-1}
1	20–40	47	51	2	8.69E-06	6.57E-06
2	30–40	42	44	14	2.02E-06	8.72E-07
3	30–50	52	40	8	3.86E-06	7.60E-06
4	30–40	57	31	12	3.33E-06	1.94E-06
5	30–50	47	45	8	3.85E-06	7.30E-06
6	15–35	36	47	17	2.11E-06	1.84E-06
7	25–45	60	31	9	4.54E-06	2.90E-05
8	20–42	30	42	28	1.37E-06	3.69E-07
9	35–55	30	47	23	1.62E-06	1.06E-06

* Note: Values of the hydraulic conductivity (K_{sat}) determined by *in situ* constant head permeability tests

Fig. 1. A compact constant head permeameter test

PTFs that allow the prediction of the hydraulic properties with limited or more extended sets of input data as soil texture data, particle-size distribution, bulk density, etc. (Schaap et al., 2001).

Results and discussion

A series of nine infiltration tests was conducted at different points spread mainly at the central and eastern part of the studied area by using the compact device (Fig. 1). In correspondence, a series of nine particle-size distribution analyses was performed in the laboratory.

A comparison of the results shows that at 6 points the values obtained by both methods are identical or similar, i.e. points numbers 1, 3, 4, 5, 6, and 9 (Table 1). At one point (No 2) the difference is around half order of magnitude, and at the rest ones (Nos 7, 8) is under one order of magnitude. Therefore, it is possible and justified to extend the modelling area of the Ogosta River floodplain as the other soil layers will be presented with K_{sat} values determined by the PTF`s analyses. In addition, the values of the hydraulic conductivity are not high from hydrogeological point of view; hence the convection part of the water flow through the unsaturated part of the Ogosta River floodplain will be small.

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