Establishing an urban lysimeter at the Union Brewery, Ljubljana, Slovenia

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Abstract

An urban lysimeter was constructed to measure infiltration parameters within an unsaturated zone of a Pleistocene alluvial gravel aquifer in a highly urbanized and industrialized environment. Measuring probes (tensiometers, TDR probes and suction cups) were installed in 42 boreholes in six layers. Lysimeter construction and the initial results of physical parameters are presented in this paper.

Key words: urban lysimeter, alluvial gravel aquifer, unsaturated zone, urban recharge, tensiometer, TDR probe, suction cup

Introduction

The basic idea (A. Juren and Prof. M. Veselic) was to construct an urban lysimeter and to measure infiltration parameters within a Pleistocene alluvial gravel aquifer in a highly urbanized and industrialized environment. The urban lysimeter is located at Union Brewery in Ljubljana, Slovenia.

Setting up an urban lysimeter

Boreholes were drilled on the left and right side of an 8,5 m deep shaft beneath a railway track, with walls reinforced with jet grouting. The grouting caused barriers for drilling, so it was necessary to make precise geodetic measurements in order to project boreholes with their end in the exact planned positions. 36 boreholes with lengths from 6 to 8 m were drilled in six horizontal layers on the right side of the shaft (at 0.30, 0.60, 1.20, 1.80, 3.00 and 4.00 m depths, measured from the bottom of a 0.66 m thick railway gravel bed, which was the initial ground surface). A further six boreholes were drilled into the left side of the shaft under an asphalt surface at depths of 0.60, 1.20 and 1.80 m. Before the installation of the probes, the geode-

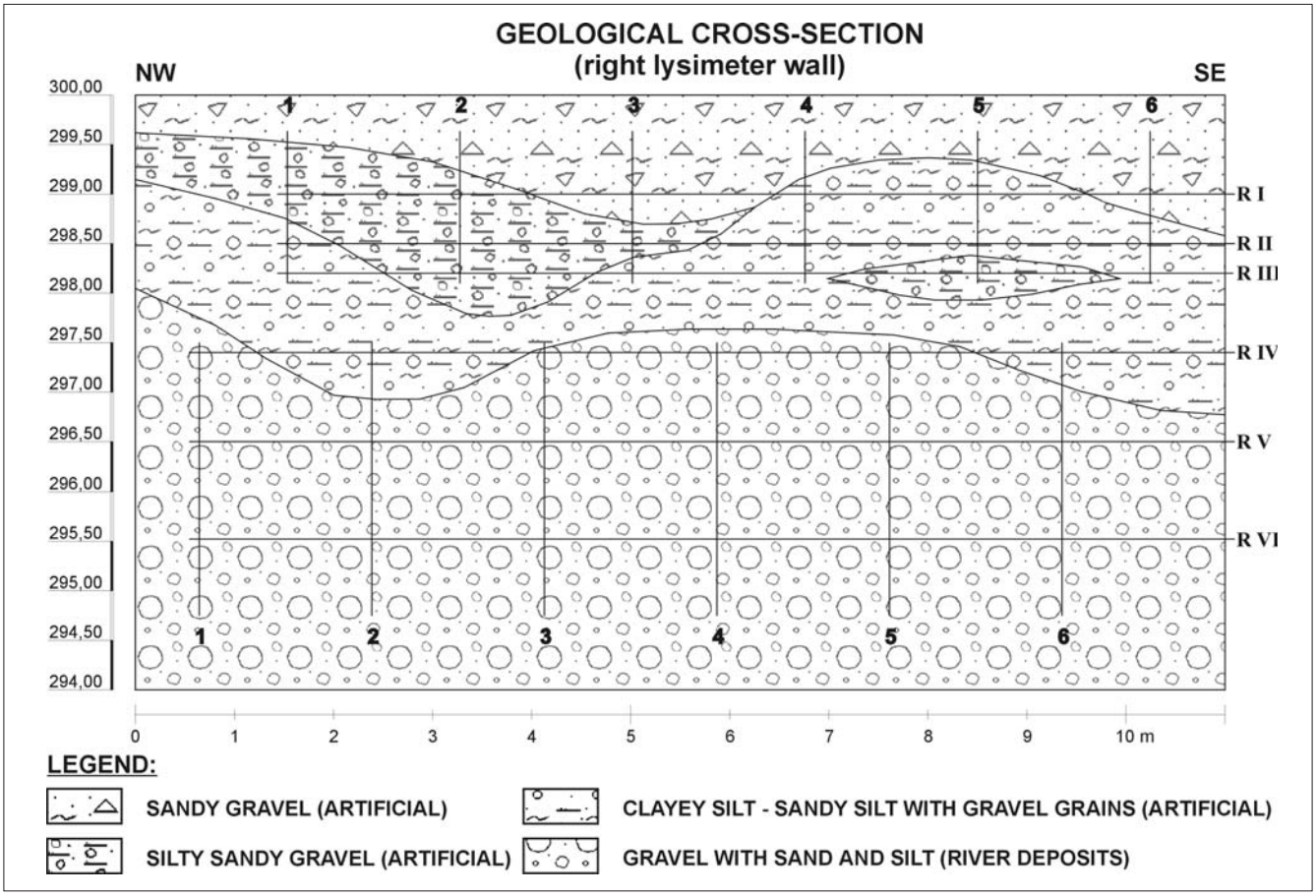

Figure 1: **Geological cross-section on the right side of the lysimeter at the end of the boreholes, with scheme of measurement and sampling points (designed by M. Pregl).**

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Table 1: **Position of measurement probes on the right and left side of the Union urban lysimeter (SC - suction cup, TS - tensiometer and TDR - Time Domain Reflectometry probe).**

			borehole name - probe type					
	depth [m]	*layer label*	*1*	*2*	*3*	*4*	*5*	*6*
right side	0,3	*R I*	RI/1 - KS	RI/2 - KS	RI/3 - KS	RI/4 - TDR	RI/5 - TS	RI/6 - TS
	0,6	*R II*	RII/1 - KS	RII/2 - KS	RII/3 - KS	RII/4 - TDR	RII/5 - TS	RII/6 - TS
	1,2	*R III*	RIII/1 - KS	RIII/2 - KS	RIII/3 - KS	RIII/4 - TDR	RIII/5 - TS	RIII/6 - TS
	1,8	*R IV*	RIV/1 - KS	RIV/2 - KS	RIV/3 - KS	RIV/4 - TDR	RIV/5 - TS	RIV/6 - TS
	3,0	*R V*	RV/1 - KS	RV/2 - KS	RV/3 - KS	RV/4 - TDR	RV/5 - TS	RV/6 - TS
	4,0	*R VI*	RVI/1 - KS	RVI/2 - KS	RVI/3 - KS	RVI/4 - TDR	RVI/5 - TS	RVI/6 - TS

	depth [m]	*layer label*	borehole name - probe type	
left	0,6	*L I*	LI/4 - TS+KS	LI/1 - TDR
	1,2	*L II*	LII/5 - TS+KS	LII/2 - TDR
	1,8	*L III*	LIII/6 - TS+KS	LIII/3 - TDR

tic measurements were repeated to determine the precise position of each measuring or sampling point. A detailed geological cross-section was generated from the borehole cores. *Figure 1* depicts the geological situation at the end of the boreholes on the right side of the lysimeter.

The completed urban lysimeter was equipped with a UMS environmental monitoring system. UMS supplied the lysimeter with sensors (21 suction cups, 15 tensiometers and 9 TDR probes), a data recording system and a sampling system. On the right side of the lysimeter each layer was equipped with a single type of measuring probe: one tensiometer, one TDR probe and three suction cups. On the left side of the lysimeter each layer was equipped with a twin probe assembly (a tensiometer probe and a suction cup) and a single TDR probe. A scheme of probes disposition is presented in *Table 1*.

Measurements of physical parameters

Soil moisture and capillary pressure are measured continuously. Capillary pressure values in tensiometers on the right side, in position 6 (Ri/6, i=I-VI, see *Table 1*) are presented in *Figure 2*. The highest reaction to precipitation was observed in layers II-IV, which are positioned in clayey- silt (see *Figure 1*). There is only a very small reaction to precipitation in the other three probes, since they are positioned in gravel. On the other hand, TDR probes show a rise of moisture after each precipitation event.

Conclusions

The construction and equipping of the urban lysimeter is the first step to the recognition of the role and behaviour of the upper unsaturated groundwater zone in the alluvial gravel aquifer in the highly urbanized environment.

On the basis of borehole core mapping and measurements of soil moisture and capillary pressure we can conclude that the unsaturated zone in the area of Union urban lysimeter is very heterogeneous. Probes with fairly fast reactions to precipitation events indicate fast preferential flow, whereas probes with small reactions indicate slow flow.

Acknowledgements

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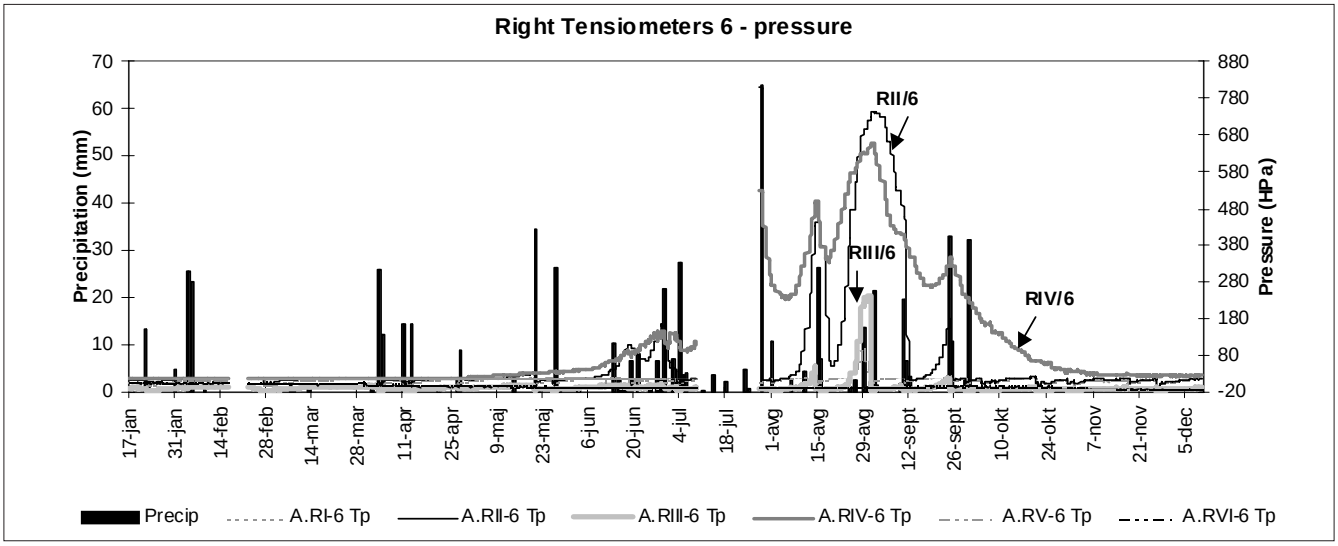

Figure 2: **Capillary pressure values in measuring points Ri/6 (i=I-VI, see *Figure 1*)**