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Moisture regime in the upper part of the loess complex in North-Eastern Bulgaria

Влажностен режим в приповърхностната част на льосовия комплекс в Североизточна България

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Introduction

Loess and loess-like sediments cover approximately 11% of the Bulgarian territory mostly in northern part of the country. From the Danube River to the Fore-Balkan, the loess soils together with paleosoils constitute a loess complex where its depth varies from 50–60 meters in north to few meters in south, respectively. Generally, the unsaturated zone is associated with the loess complex (Minkov, 1968). That complex has active role in the formation of the groundwater recharge in Northern Bulgaria. The loess complex is basement for numerous important constructions of significant civil and industrial centres along the Danube River including Kozloduy NPP, potential Belene NPP, chemical plants in Ruse town, etc. The downward flux through the loess cover goes to the groundwater recharge. Thus, the moisture regime in the unsaturated zone is of great importance both for civil engineering, agriculture and environmental aspects.

The unsaturated water flow through loess in Northern Bulgaria (including water balance studies) was investigated by Spasov (1966), Minkov (1968) and others. The water flux through loess occurs as a diffuse flow through the unsaturated zone subject to various meteorological, landscaping and soil texture factors.

The present study describes the temporal variations of the soil moisture in the unsaturated zone in respect to rainfall series. It refers to undisturbed profile of the typical loess at the North-Eastern Bulgaria.

Materials and methods

The experimental site is located in the vicinity of the town of Ruse at a high river bank. The soil texture is generally silty loam. The terrain is flat, covered by grass. The soil moisture was measured by sensors (10HS by Decagon company) installed at three depths, namely 0.55, 1.00, and 1.50 m from the land surface. Rainfall was recorded by an automatic rain gauge (PRONAMIC company). All the equipment was operated by the GPRS datalogger produced by ADCON company. The data were collected at every 20 minutes interval for the period September 2015–February 2017. The exact specifications of the used equipment and the procedure for installing the underground sensors are described in details in Antonov et al. (2015).

Results and discussion

Monthly average values of the volumetric water content and the monthly precipitation sums are presented on Figure 1. The water content at depths 0.55 and 1.0 m are much more sensitive to the rainfalls and drought period in the period from August 2015 to November 2016 compared to this at 1.5 m. In general the moisture content at 1.5 m varies only about 5% – from 10% to 15% for all the studied period (Fig. 1). In the beginning of the drought period (middle of July 2016) the water content at 1.0 m decreased from 25% to 15% and after the starting of rainfalls (September–October 2016) did not recover in contrast with this at 0.55 m (Fig. 1).

As the groundwater level in the site is more than 14 m below the terrain surface (Antonov et al., 2015), the results from the 18th months of observation can be interpreted as a small but relatively stable downward flux, which keeps the water content at 1.5 m in a relatively constant range. Evidently, the groundwater is recharged by diffuse infiltration through the thick loess cover. For similar conditions in Loess Plateau (Northern China) Huang et al. (2017) proved that

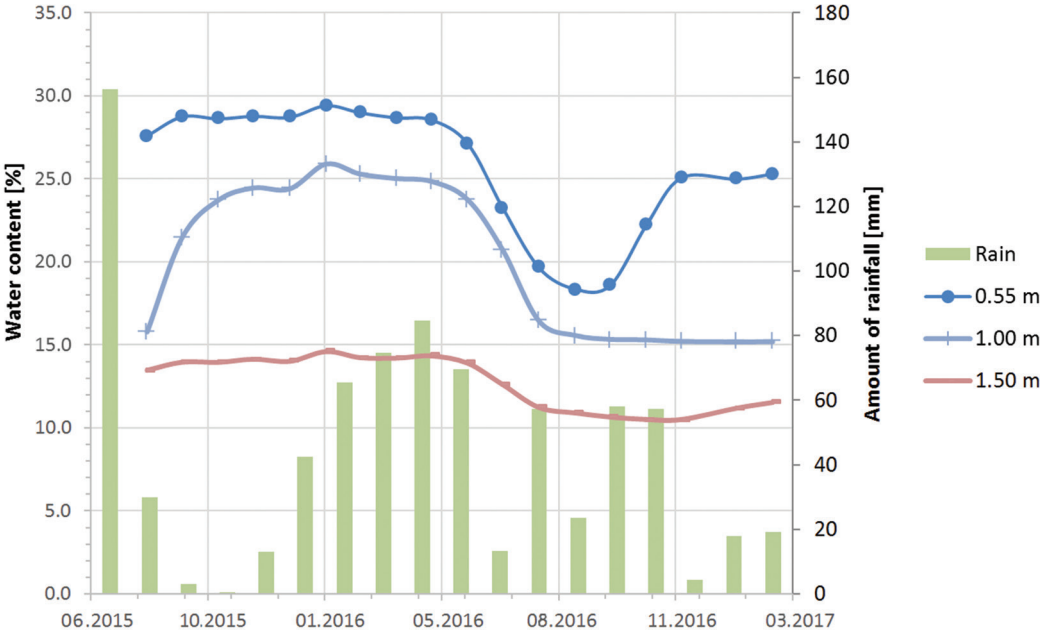

Fig. 1. Moisture observations at three depths in the loess profile for the period of 18 months

piston flow is the dominant recharge mechanism for groundwater.

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