Multi-layers Effect on Evaporation Rates from Unsaturated Sandy Soil

HASHEM M^{*}., MOHAMED A. A., WATANABE K^{*}., ALI N. A., MOHAMED A. A., and ABDEL-LAH A. K.

*JSCE members

Saitama University, Japan Assiut University, Egypt

1. Introduction: Evaporation is an important parameter on upward solute transport, hydrological and other environmental matters. In arid and semi-arid zones the downward movement of the pollutants near the soil surface rarely occurs, the evaporation is the main factor which can cause the upward pollutant migration. Most of the areas of the arid zones are desert, covered by a surface of sandy soil. Three experiments were carried out under the same conditions to estimate the values of the evaporation rate in three types of soil as, fine sand, coarse sand and multi-layered sandy soil.

2. Measuring apparatus :

The schematic view of the measuring apparatus is shown in Fig. 1. It is mainly consists of two units: Ventilated chamber and an evaporation measuring equipment developed by Mohamed et al. (1998). The main idea of the equipment is, if some parts of the ground surface are covered by a box made of transparent sheet and the air is injected into one side and exhausted from the other side, the absolute humidity of the air increased when the vapor is coming out from the ground surface by evaporation or evapo-transpiration.

3. Experimental work: Three laboratory experiments were carried out on three types of sand. All the experiments were carried out under the same conditions. The average air temperature was 25.5 °C and its relative humidity was 59.0 %. The ventilated chamber was placed over a soil box which has the same horizontal area. A constant level of groundwater was kept through the groundwater supply tank for each experiment.



Fig. 1. Schematic view of the measuring apparatus

For unsaturated fine sand depth (d_{FS}) was 60 cm while the coarse sand depth (d_{CS}) was 25 cm. The physical properties of each type of sand are given in Table 1. In the two layers experiment, the coarse sand was placed as the upper layer and the fine sand as the lower layer, $d_{CS} = 25$ cm and $d_{FS} = 35$ cm.

4. Discussion and analysis of results: During the time of each experiment the temperature, relative humidity, air flow rate and the surface area of the soil column (constant for all experiments) were used to calculate the evaporation (Brutseart, 1982). Transient changes of the evaporation rate and the average value for all types are shown as in Figs. 2, 3, and 4.

5. Conclusions: The Evaporation rate could be calculated during all experiments for each type of soil. The average values of the evaporation rate (shown in the figures) were different according to sand type. The evaporation rate from the surface of the fine sand was found to be larger than that from the coarse sand, even the groundwater table was

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Hydroscience & Geotechnology Lab., Civil and Envir. Eng. Dept., Graduate School of Science and Eng., Saitama University.,

more deeper in the first case than that in the second case. In the case of multi-layers soil, when the coarse sand was the upper layer, the evaporation rate was found to be less than from each type of soil.

Tuble 1.1 roperties of bour fine and course sand used in this study.					
Sand	Mean diameter	Sp.	Bulk density	Porosity	Sat. Hyd. conductivity
type	(mm)	gravity	(g/cm^3)	(%)	(cm/s)
Fine	0.19	2.653	1.42	44.5	0.029
Coarse	1.34	2.47	1.50	39.6	0.047

Table 1. Properties of both fine and coarse sand used in this study.



Fig. 2. Transient change of the evaporation rate for fine sand experiment.



Fig. 3. Transient change of the evaporation rate for coarse sand experiment.



Fig. 4. Transient change of the evaporation rate for multi-layers experiment.

References:

- 1. Brutseart, W., 1982. "Evaporation into the atmosphere". Kluwer Academic Publisher.
- 2. Mohamed, A. A., K. Watanabe, and T. Sasaki 1998. "Ventilated Chamber system for continuous recording of both the evaporation rate and the heat balance at the bare soil surface." Journal of Groundwater Hydrology. 40(2): 185-202.