Geophysical Research Abstracts
Vol. 17, EGU2015-2944, 2015
EGU General Assembly 2015

On the impact of entrapped air in infiltration under ponding conditions. Part a: Preferential air flow path effects on infiltration

Guy Mizrahi (1), Noam Weisbrod (1), and Alex Furman (2)

(1) Zuckerberg Institute for Water Research, Ben Gurion University of the Negev, Beer Sheva, Israel (guymiz@post.bgu.ac.il), (2) Civil and Environmental Engineering, Technion, Haifa,Israel (afurman@technion.ac.il)

Entrapped air effects on infiltration under ponding conditions could be important for massive infiltration of managed aquifer recharge (MAR) or soil aquifer treatment (SAT) of treated wastewater. Earlier studies found that under ponding conditions, air is being entrapped and compressed until it reaches a pressure which will enable the air to escape (unstable air flow). They also found that entrapped air could reduce infiltration by 70-90%. Most studies have dealt with entrapped air effects when soil surface topography is flat. The objective of this study is to investigate, under ponding conditions, the effects of: (1) irregular surface topography on preferential air flow path development (stable air flow); (2) preferential air flow path on infiltration; and (3) hydraulic head on infiltration when air is trapped.

Column experiments were used to investigate these particular effects. A 140 cm deep and 30 cm wide column packed with silica sand was used under two boundary conditions: in the first, air can only escape vertically upward through the soil surface; in the second, air is free to escape through 20 ports installed along the column perimeter. The surface was flooded with 13 liters of water, with ponding depth decreasing with time. Two soil surface conditions were tested: flat surface and irregular surface (high and low surface zones). Additionally, Helle-show experiments were conducted in order to obtain a visual observation of preferential air flow path development. The measurements were carried out using a tension meter, air pressure transducers, TDR and video cameras.

It was found that in irregular surfaces, stable air flow through preferential paths was developed in the high altitude zones. Flat surface topography caused unstable air flow through random paths. Comparison between irregular and flat surface topography showed that the entrapped air pressure was lower and the infiltration rate was about 40% higher in the irregular surface topography than in the flat surface topography. No difference of infiltration rate between flat and irregular surface topography was observed when air was free to escape along the infiltration path. It was also found that at the first stage of infiltration, higher hydraulic heads caused higher entrapped air pressures and lower infiltration rates. In contrast, higher hydraulic head results in higher infiltration rate, when air was free to escape.

Our results suggest that during ponding conditions: (1) preferential air flow paths develop at high surface zones of irregular topography and increase infiltration rate; and (2) higher ponding depths increase entrapped air pressure and decrease infiltration rate if air cannot escape.

Keywords: Ponding condition, Entrapped air, Infiltration, Surface topography, Preferential air flow paths