Abstract

An increase in soil water suction due to root water uptake is significant for stability of slopes and landfill covers as it increases shear strength of soil by 50%. Coupled effects of soil density changes in soil hydraulic properties [*i.e.*, soil water characteristic curve (SWCC) and hydraulic conductivity] and root characteristics (root depth, vertical root distribution) found in past experimental studies may affect soil water suction, which are not fully understood. The objective of this study is to numerically investigate these coupled effects of soil density by systematically comparing suction profiles under three different scenarios: (1) changes in only soil hydraulic properties, (2) changes in only root characteristics, and (3) changes in both soil properties and root characteristics. Silty sand with two different degrees of compaction (DoC) (*i.e.*, 82% and 89%), which are typically found on man-made slopes in subtropical regions, is considered. *Schefflera heptaphylla* is selected as vegetation species, which is commonly used for ecological restoration for man-made slopes. A laboratory experiment was conducted to quantify suction distribution in silty sand vegetated with *Schefflera heptaphylla* at DoC of 89%. Vertical root distribution was measured using image analysis, while an axi-symmetric finite element analysis was conducted to calibrate transpiration rate from measured suction. Root characteristics corresponding to DoC of 82% were then deduced using observations from literature. Richards equation coupled with sink term was numerically solved using Vadose/W to simulate water flow and root uptake on a flat ground (5 m depth, 10 m wide). Soil hydraulic parameters from a completely decomposed granite soil for two different DoCs (82% and 89%) were considered. Simulations assume constant transpiration rate for a period of 10 d. With increase in soil density from DoC of 82% to 89%, computed suction increases by 110% for scenario 1 (only effect on soil hydraulic properties), whereas it decreases by at least 21% for scenarios 2 (only root characteristics) and 3 (coupled effect). Here, a higher unsaturated hydraulic conductivity and a lower actual transpiration rate balance effects of a lower desorption rate of SWCC.