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A hydroecological technique to improve infiltration of clogged bed of recharge dam in Oman

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ABSTRACT

Recharge dams represent one of few engineering techniques to harvest flashfloods water in arid zones for augmenting the limited water resources. Formation of a low-permeable cake by deposition of suspended particles transported by ephemeral floods is a common problem for dams in arid regions (e.g., Oman, Saudi Arabia, Iran, and Tunisia). Accumulation of surface sediments affects many hydrological properties of dam's reservoir area, including reduced infiltration and deep percolation rates, higher water loss via evaporation, and ultimately lower aquifer recharge and higher flood peaks. The recharge basin downstream the dam receives pulses of suspended sediments after each major flashflood. This causes a "hopping" downward translocation of fine particles into the coarse-texture matrix of the alluvium bed, clogging of the pores which significantly reduces the saturated hydraulic conductivity (K_s). The intermittent flashfloods forms multilayered heterogeneous soil profile and a resultant non-monotonic cumulative infiltration curves have intricate hydro-engineering implications, for example, we observed that the runoff water, released from the dam, instead of a fast vertical infiltration, forms a shallow quasi-horizontal Darcian flow that out-seeps further downstream into local topographic depressions and contributes to undesired runoff-evaporation. Hence, finding practical solutions to overcome the consequences of the siltation problem of dam beds is of a paramount importance. In this work, we investigated the possibility of applying a hydro-ecological method to combat the cake-clogging curse. We experimentally (using pots experiment) and numerically (using HYDRUS-2D code) quantified the effect of roots of indigenous trees, namely Sidr (*Ziziphus spina-christi*) grown in soil pots on increasing infiltration through a clogged layer. The pots were exposed to two flood events over 12 months period of cultivation. The average initial infiltration rates for vegetated pots (240 and 147 mm/h for F1 and F2, respectively) which is 2.4 and 2.1 times higher than that for pots without plants, bare soil (around 85 mm/h in average). For vegetated pots, the final infiltration rates (K_s) were higher by 1.7 and 3.3 times than that for the control pots, ($p < 0.05$). The numerical modeling illustrated the effect of the root system on the dynamics of soil water. The root system enhances the propagation of the soil water in both lateral and vertical directions. The results indicate the feasibility of this hydroecological technique in improving the infiltration rate and hence the recharge efficiency of recharge dams in arid areas.

Keywords: Clogging; Pore space; Infiltration; Arid zone; Recharge dams; HYDRUS-2D; Root water uptake; Ziziphus spina-christi

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