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# A modeling approach to estimate groundwater recharge from infiltration in the unsaturated zone: Siloam Village case study

By

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# ABSTRACT

A study has been done to estimate groundwater recharge from infiltration in the vadose zone using a modeling approach. Accurate estimates of groundwater recharge are indispensable for effective groundwater resource management especially in arid and semi-arid regions where supplies are limited. Moreover, aquifer recharge from infiltration of precipitation is a vital component in the overall subsurface water balance. To obtain estimates of recharge in Siloam Village, a delineated portion of the sub quaternary catchment A80A in Limpopo Province, a vadose zone HYDRUS1-D model was applied. HYDRUS1-D is a physically based finite element model capable of simulating water flux in the vadose zone and uses the 1D-Richard's equation, which required the relationships of both the moisture retention function and the hydraulic conductivity curve. Soil hydraulic characteristics were estimated using an indirect method entailing pedotransfer functions in the Rosetta stone model. A total of 3 monitoring sites were used and at each site, a HYDRUS-1D model was calibrated using field data of soil moisture for 1701 hours. A vertical electrical sounding survey was also carried out along a profile of 250 m within the study area to estimate the groundwater level. The estimated groundwater level was at 21 m and thus served as lower boundary for the model while the atmospheric conditions were used as the upper boundary. Simulations were done for infiltration in both hysteretic and non hysteretic modes for the 3 sites up to a depth of 1.8 m. Site 1 was made up of three horizons; clay, sandy clay and sand in descending order. Site 2 was made up of clay and sandy soils while site 3 was made up of loamy sand and sand. Average recharge estimates during non-hysteretic flow were estimated to be in the range 4.57E-03 to 0.0159 mm/hr while for hysteretic flow they ranged from 5.36E-03 to 0.0171 mm/h with the highest recharge rate occurring at site 1. The van Genuchten hydraulic parameters were found to be the most sensitive in estimating recharge with the highest being α and n. The model performance was evaluated with coefficient of correlation ($R^2$), Mean Average Error (MAE), and Root Mean Square Error (RMSE) between measured and calculated water contents. $R^2$ was above 0.5, which is the acceptable range while MAE and RMSE were close to 0, which indicate a good agreement with observed data.