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A holistic water depth simulation model for small ponds

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SUMMARY

Estimation of time varying water depth and time to empty of a pond is prerequisite for comprehensive and coordinated planning of water resource for its effective utilization. A holistic water depth simulation (HWDS) and time to empty (TE) model for small, shallow ephemeral ponds have been derived by employing the generalized model based on the Green–Ampt equation in the basic water balance equation. The HWDS model includes time varying rainfall, runoff, surface water evaporation, outflow and advancement of wetting front length as external inputs. The TE model includes two external inputs; surface water evaporation and advancement of wetting front length. Both the models also consider saturated hydraulic conductivity and fillable porosity of the pond's bed material as their parameters. The solution of the HWDS model involved numerical iteration in successive time intervals. The HWDS model has successfully evaluated with 3 years of field data from two small ponds located within a watershed in a semi-arid region in western India. The HWDS model simulated time varying water depth in the ponds with high accuracy as shown by correlation coefficient ($R^2 \geqslant 0.9765$), index of agreement ($d \geqslant 0.9878$), root mean square errors (RMSE $\leqslant 0.20$ m) and percent bias (PB $\leqslant 6.23\%$) for the pooled data sets of the measured and simulated water depth. The statistical F and t-tests also confirmed the reliability of the HWDS model at probability level, $p \leqslant 0.0001$. The response of the TE model showed its ability to estimate the time to empty the ponds. An additional field calibration and validation of the HWDS and TE models with observed field data in varied hydro-climatic conditions could be conducted to increase the applicability and credibility of the models.

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