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Integration of system theoretic and system dynamics modeling techniques for Prediction of soil moisture

S Sanaga (1), A Elshorbagy (2), and N Kestha (3)

(1) Centre for Advanced Numerical Simulation (CANSIM), Department of Civil & Geological Engineering, University of Saskatchewan, Saskatoon, SK, Canada S7N 5A9 (sanagas@gmail.com), (2) Centre for Advanced Numerical Simulation (CANSIM), Department of Civil & Geological Engineering, University of Saskatchewan, Saskatoon, SK, Canada S7N 5A9, (3) Centre for Advanced Numerical Simulation (CANSIM), Department of Civil & Geological Engineering, University of Saskatchewan, Saskatoon, SK, Canada S7N 5A9

Soil moisture measurements are important to ascertain the functionality of the hydrologic system of natural and reconstructed watersheds. Historically, researchers have employed modeling techniques available for estimating soil moisture, viz., mechanistic or systems theoretic, in isolation. These techniques, when used individually, provide reasonable accuracy in modeling and predicting soil moisture. This study presents an integrated approach for soil moisture prediction in an attempt to achieve better prediction accuracy. The integrated model uses conceptual/mechanistic and ANN modeling techniques. A comprehensive methodology is proposed and used to identify proper input variables for developing the soil moisture model. The present methodology uses mutual information method to identify proper input variables for developing the model by accounting for both linear and nonlinear dependence between input and output variables. Furthermore, genetic programming is used to find out the significance of certain input variables in order to eliminate redundant variables.

The observed weather data and the various simulated components from a lumped conceptual model (The Generic System Dynamic Watershed (GSDW) model) are used to predict soil moisture content for reconstructed watersheds at northern Alberta, Canada. The present work compares two ANN models: one uses observed weather data as inputs, and the other model utilizes observed data with simulated components obtained from the GSDW model to develop an integrated modeling framework capable of exploiting the advantages of conceptual and ANN techniques. It is demonstrated that the integrated modeling approach is effective for predicting soil moisture. Moreover, the results from the ANN models are utilized to explain the efficiency of the GSDW model in simulating the hydrological processes.