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Title: RAINFALL-RUNOFF MODELLING USING ADAPTIVE NEURO-FUZZY TECHNIQUE

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Abstract: The prediction of runoff is fundamental in water resources planning and management in watershed. Runoff estimation is the critical to many activities such as designing flood protection work for urban areas and agricultural lands. Modelling of Rainfall-runoff process is complex in nature due to nonlinear relationship between rainfall and runoff. There are various sophisticated and exhaustive models evolved over a period of time to predict runoff from the rainfall and other watershed based parameters. These include empirical models, conceptual models and physical models. One of the major lacunae with the existing models describing the rainfall-runoff process is that most of them require large number of watershed characteristic parameters for accurate prediction of runoff from known values of the causative factors. Regular monitoring of these parameters is a cumbersome process and is also expensive. In recent years, the use of soft computing techniques such as Artificial Neural Network (ANN), Fuzzy Logic and Adaptive Neuro Fuzzy Inference System (ANFIS) in the field of runoff estimation are gaining ground. An ANFIS based model was developed for rainfallrunoff relationship combining the capabilities of ANN and Fuzzy Logic. The ANFIS incorporates the concepts of neural network learning in fuzzy inference systems and has the ability to model any nonlinear function. In this study, ANFIS models were developed using MATLAB© 7.6. The model was applied for the estimation of runoff using the recorded event-based hydrological data from 1993 to 2001 in Banha Watershed, located in DVC, Jharkhand, India. Randomly selected 61 rainfall event data was used for the analysis. Based on number of input parameters required for accurate estimation of runoff, five modelling strategies was devised using stepwise regression on entire data set with backward elimination. Five ANFIS based models were developed each for one strategy. Trial and error procedures were attempted with different combinations of number and types of input and output membership functions, number of rules and number of epochs to develop models. The ANFIS based model with modelling strategy A which includes all five input variables, back propagation learning algorithm, Gaussian II input membership function and linear output membership function exhibited better results with Wilmot's Index of Agreement (IoA), Coefficient of Determination (R^2), RMSE and MSE of 0.98, 0.91, 2.94 mm and 2.18 mm, respectively for training data set and 0.92, 0.81, 3.22mm and 2.62 mm, respectively for testing data set. ANFIS based model results were compared with standard Natural Resources Conservation Services Curve Number (NRCS-CN) method and multiple linear regression (MLR) approach. Comparison showed that ANFIS based model provides a better prediction of runoff than NRCS-CN model. Comparison also showed that all the five ANFIS based models provide better prediction of runoff than the MLR models. The study showed the applicability of Adaptive Neuro-Fuzzy Inference technique in prediction of runoff in small watersheds on event basis.

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