STREAMFLOW FORECASTING USING NEURO-FUZZY INFERENCE SYSTEM

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The prediction of flow into a reservoir is fundamental in water resources planning and management. The need for timely and accurate streamflow forecasting is widely recognized and emphasized by many in water resources fraternity. Real-time forecasts of natural inflows to reservoirs are of particular interest for operation and scheduling. The physical system of the river basin that takes the rainfall as an input and produces the runoff is highly nonlinear, complicated and very difficult to fully comprehend. The system is influenced by large number of factors and variables. The large spatial extent of the systems forces the uncertainty into the hydrologic information. A variety of methods have been proposed for forecasting reservoir inflows including conceptual (physical) and empirical (statistical) models (WMO 1994), but none of them can be considered as unique superior model (Shamseldin 1997). Owing to difficulties of formulating reasonable non-linear watershed models, recent attempts have resorted to Neural Network (NN) approach for complex hydrologic modeling.

In recent years the use of soft computing in the field of hydrological forecasting is gaining ground. The relatively new soft computing technique of Adaptive Neuro-Fuzzy Inference System (ANFIS), developed by Jang (1993) is able to take care of the non-linearity, uncertainty, and vagueness embedded in the system. It is a judicious combination of the Neural Networks and fuzzy systems. It can learn and generalize highly nonlinear and uncertain phenomena due to the embedded neural network (NN). NN is efficient in learning and generalization, and the fuzzy system mimics the cognitive capability of human brain. Hence, ANFIS can learn the complicated processes involved in the basin and correlate the precipitation to the corresponding discharge.

In the present study, one step ahead forecasts are made for ten-daily flows, which are mostly required for short term operational planning of multipurpose reservoirs. A Neuro-Fuzzy model is developed to forecast ten-daily flows into the Hirakud reservoir on River Mahanadi in the state of Orissa in India. Correlation analysis is carried out to find out the most influential variables on the ten daily flow at Hirakud. Based on this analysis, four variables, namely, flow during the previous time period, ql1, rainfall during the previous two time periods, rl1 and rl2, and flow during the same period in previous year, qpy, are identified as the most influential variables to forecast the ten daily flow.

Performance measures such as Root Mean Square Error (RMSE), Correlation Coefficient (CORR) and coefficient of efficiency R^2 are computed for training and testing phases of the model to evaluate its performance. The results indicate that the ten-daily forecasting model is efficient in predicting the high and medium flows with reasonable

accuracy. The forecast of low flows is associated with less efficiency.

REFERENCES

Jang, J.S.R. (1993). "ANFIS: Adaptive - network- based fuzzy inference system." IEEE Trans. on Systems, Man and Cybernetics, 23 (3), 665-685.

Shamseldin, A.Y. (1997). "Application of a neural network technique to rainfall-runoff modeling." Journal of Hydrology, 199, 272-294.

World Meteorological Organization (1975). Intercomparison of conceptual models used in operational hydrological forecasting. World Meteorological Organization, Technical Report No.429, Geneva, Switzerland.