Review: Rainfall Runoff Modelling

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***Abstract*- Hydrological modeling is a commonly used tool to estimate the basin's hydrological response due to precipitation. There are many limitations of hydrological measurement techniques. We have, in fact, only a limited range of measurement techniques and a limited range of measurements in space and time. We therefore need a means of extrapolating from those available measurements in both space and time, particularly to ungauged catchments (where measurements are not available) and into the future (where measurements are not possible) to assess the likely impact of future hydrological change. Models of different types provide a means of quantitative extrapolation or prediction that will hopefully be helpful in decision making.**

Key words- Rainfall, Runoff , ANN, Fuzzy logic Model, SWMM, HEC-HMS, Hydrologic modelling

I. INTRODUCTION

Rainfall is the major component of the hydrologic cycle and this is the primary source of runoff. Worldwide many attempts have been made to model and predict rainfall behavior using various empirical, statistical, numerical and deterministic techniques.

Rainfall generated runoff is very important in various activities of water resources development and management. The method of transformation of rainfall to runoff is highly complex, dynamic, nonlinear, and exhibits temporal and spatial variability. It is further affected by many parameters and often inter-related physical factors. Determining a robust relationship between rainfall and runoff for a watershed has been one of the most important problems for hydrologists, engineers, and agriculturists.

The rainfall-runoff relationship is an important issue in hydrology and a common challenge for hydrologists. Due to the tremendous spatial and temporal variability the impact of rainfall on runoff becomes more intensive and their proper estimate is essential for flood management.

Since the middle of the 19th century, different methods have been demonstrated by hydrologists to assess the impact of rainfall on runoff whereupon many models have attempted to describe the physical processes involved in it.

These rainfall-runoff models generally fall into black box or system theoretical models, conceptual models and physically-based models. Black box models normally contain no physically based input and output transfer functions and therefore, are considered to be purely empirical models.

Conceptual rainfall-runoff models usually incorporate interconnected physical elements with simplified forms, and each element is used to represent a significant or dominant constituent hydrologic process of the rainfall-runoff transformation.

Physically based model are distributed models consists a large number of parameters as input to the model.

II. LITERATURE REVIEWS

Geoffrey O'Loughlin, Wayne Huber & Bernard Chocat (2007)[1]

Rainfall-runoff models are the backbone of almost all urban stormwater management studies, for mitigation of flooding problems or on alleviation of stormwater pollution. These both objectives require estimates of stormwater flows. this paper outlines about the basic theory of rainfall runoff process and development of modelling practice and current use of computer models. it also highlights about deficiencies and dilemmas of rainfall runoff modelling.

A. R. Senthil Kumar, K.P. Sudheer, S.K.Jain and P. K. Agarwal (2005)[2]

This paper presents a comprehensive evaluation of the performance of MLP-(multi-layer perceptron) and RBF-(radial basis function) type neural network models developed for rainfall-runoff modelling of Malaprabha catchment, India. A comparison of the rainfall-runoff modelling skill of two ANN configurations, i.e. an MLP and an RBF is presented. The results suggest that the choice of the type of network certainly has an impact on the model prediction accuracy. However, the results of the study indicate that the generalization properties of RBF networks are poor compared with those of MLPs in rainfall-runoff modelling. But a judgment on which is superior is clearly not possible from this study.

AnilKumar Lohani, N.K. Goel & K.K.S.Bhatia (2011)[3]

This paper compares artificial neural network (ANN), fuzzy logic (FL) and linear transfer function (LTF)-based approaches for daily rainfall-runoff modelling. This study also investigates the potential of Takagi-Sugeno (TS) fuzzy model and the impact of antecedent soil moisture conditions in the performance of the daily rainfall-runoff models.

Eleven different input vectors under four classes, i.e. (i) rainfall, (ii) rainfall and antecedent moisture content, (iii) rainfall and runoff and (iv) rainfall, runoff and antecedent moisture content are considered for examining the effects of input data vector on rainfall-runoff modelling. Using the rainfall-runoff data of the upper Narmada basin, Central India, a suitable modelling technique with appropriate model input structure is suggested on the basis of various model performance indices. The results show that the fuzzy modelling approach is uniformly outperforming the LTF and also always superior to the ANN-based models.

Keh-Han Wang and Abdusselam Altunkaynak(2012)[4]

In this paper a comparative case study between SWMM and a fuzzy logic model for the predictions of total runoff within the watershed of Cascina Scala, Pavia in Italy is presented.

A data set of 23 events from 2000 to 2003 including with the total rainfall and total runoff are adopted to train fuzzy logic parameters. Other data (1990–1995) with detailed time variations of rainfall and runoff are available for the setup and calibration of SWMM for runoff modeling. Among the 1990–1995 data, 35 independent rainfall events are selected to test the prediction performance of the SWMM and fuzzy logic models by comparing the predicted total runoffs with measured data. The performance of the SWMM and the fuzzy logic model were analyzed using root-mean-squared error and coefficient of efficiency.

Generally, both the SWMM and fuzzy logic model can predict runoffs that agree reasonably well with the measured data. however, the physically based SWMM produced the time varying hydrograph whereas the fuzzy logic model was subject to the limitation of the methodology and was unable to generate such an output.

Kishor Choudhari, Balram Panigrahi, Jagadish Chandra Pau (2014)[5]

In this paper HEC-HMS model is used to simulate rainfall-runoff process in Balijore Nala Watershed of Odisha, India. To compute runoff volume, peak runoff rate, base flow and flow routing methods SCS curve number, SCS unit hydrograph, Exponential recession and Muskingum routing methods are chosen, respectively. Rainfall- runoff simulation is conducted using 24 random rainstorm events covering four year (2010 – 2013) data.

Out of these, 12 events are selected for model calibration and the remaining 12 for model validation. For calibration of model the statistical tests of error functions like mean absolute relative error (MARE) and root mean square error (RMSE) between the observed and simulated data are conducted. Results shows that these obtained square functions in the validated model indicate satisfactory performance of HEC-HMS model in simulation runoff hydrograph.

The model can help to save time and money in obtaining the runoff data rather than measurement of runoff in the watershed. Moreover, it may help to simulate runoff in un-gauged watershed where there is no gauging station to measure runoff.

M. P. Rajurkar , U. C. Kothyari & U. C. Chaube (2017)[6]

In this study a large size catchment of the Narmada River in Madhya Pradesh (India) is presented for modelling daily flows during monsoon flood events by the application of the Artificial neural network methodology.

Daily rainfall and runoff data for the Narmada catchment at the Jamtara gauge and discharge site located in the central Indian State of Madhya Pradesh, are used. A linear multiple-input single-output (MISO) model coupled with the ANN is shown to provide a better representation of the rainfall-runoff relationship in such large size catchments compared with linear and nonlinear MISO models.

The present model provides a systematic approach for runoff estimation and represents improvement in prediction accuracy over the other models studied herein.

M. Kh. Askar(2014)[7]

In this paper the SCS CN method is used for the calculation of runoff depth with Geographic Information Technique (GIS). The role of remote sensing in runoff calculation is generally to provide a source of input data or as an aid for estimating equation coefficients and model parameters.

The study was carried out in the Gomal River watershed about 540 km^2 catchment areas, Iraq. The area within the boundary of the Kurdistan region starts from north of Shahia to south west of Dohuk City.in this study the mean annual rainfall depth for the year 1947 to 2005 is considered fot the calculation of runoff. Effect of slope on CN values and runoff depth was determined by using the WMS 7.1 program.

The result shows that the incorporation of SCS-CN model and GIS facilitates runoff estimation from watershed and can augment the accuracy of computed data.

III. CONCLUSION

- Rainfall-runoff models are the backbone of almost all urban stormwater management studies.
- The choice of the type of network certainly has an impact on the model prediction accuracy.
- There are various models for rainfall runoff modeling discussed here such as artificial neural network, fuzzy modeling or storm water management model.
- Result shows that the fuzzy logic modeling gives comparatively good output. the models compiled with ANN can also be used and give good results.
- The computer models can also be used for rainfall runoff simulation such as HEC-HMS. This model can help to save time and money in obtaining the runoff data rather than measurement of runoff in the watershed. Also, it may help to simulate runoff in un-gauged watershed where there is no gauging station to measure runoff.
- There is another method for rainfall runoff modeling known as SCS CN method, which is simple and easy method and also accurate method for computation of runoff.
- Therefore the choice or selection of model depends on type of data.

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