International Journal of Emerging Research in Management &Technology
ISSN: 2278-9359 (Volume-6, Issue-5)

Research Article | **May 2017**

Runoff Estimation of a Basin Using Tank Model

Sandeep Devaliya*, H. L. Tiwari, Ankit Balvanshi
Department of Civil Engineering, Maulana Azad National Institute of Technology, Bhopal, Madhya Pradesh, India

DOI: 10.23956/ijermt/SV6N4/128

Abstract—

Tank model is one of the very popular model of in the field of rainfall-runoff modelling. Tank model originally developed by Sugawara in 1967 an Japan but later on it is used by number of researchers, hydrologists and scholars not only in India but also in different parts of the world. This paper describes the concept of rainfall runoff modelling using Tank model. For the present study, the Tank model was used for the Narmada river basin of Central India for the GDQ site situated at Dindori, area of the basin was approximately 2292 square kilometres. Daily precipitation data, daily discharge data and daily PPT data from the year 2000 to 2003 and from 2004 to 2005 were used for the calibration and validation respectively. Coefficient of determination values were found as 0.8191 for the calibration and 0.6972 for the validation. So the values of coefficient of determination show that the model is suitable for the Narmada upper basin of central India. Scattered plot between the observed runoff values and the simulated runoff values obtained from the Tank model was also plotted. From this study it can be concluded that the Tank model is suitable for the Indian river basins for the estimation of runoff.

Keywords— Rainfall-Runoff modelling, Tank model, Coefficient of determination, Water Resources, Runoff estimation.

I. INTRODUCTION

Rainfall Runoff modelling is one of the widest area of research in the field of water resources engineering. In the recent past so much research has been done by so many researchers, scholars and hydrologists. One of the important rainfall runoff model is Tank model firstly developed and introduced in 1967 by Sugawara, a hydrologist from Japan, which shows the phenomenon of water flow in a watershed in Japan [1]. Tank model was firstly popular in Japan only but the popularity of the model is now world wide. The Tank model was later developed by Hairul Basri for the Province of Aceh, Indonesia [2]. Phien et al developed the Tank model for two watersheds in Thailand showing that the Tank model can simulate the discharge satisfactorily [3]. Tank model is also used for the different basins in India. Ramasastri K.S. used the Tank model for te simulation of runoff for the Malaprabha basin of western ghats of south part of India, the model was found very efficient for the Malaprabha basin [4]. For daily analysis for simulating streamflow, the Tank model was used by Datta in 1984 for two sub basins of Central India, the model was found suitable for this basin [5].

II. MATERIALS AND METHODS

A. Study Area

In the present study the Tank model was used for the rainfall runoff modelling of Narmada upper basin of Central India for the GDQ site situated at Dindori, latitude and longitude of which are 22.8457 N and 81.0755 E respectively. The area of the basin taken in the study was approximately 2292 square kilometres. The Dindori district is the part of Jabalpur division, located at the eastern part of Madhya Pradesh of India.

B. Input data required

The input data for the Tank model are Rainfall data, Potential Evapotranspiration data and the Discharge data for the catchment. For this study the daily data is taken for 6 years from the year 2000 to 2005 for the Narmada Upper basin. Out of which the data from 1.1.2000 to 31.12.2003 was used for the calibration of model and the data from the 1.1.2004 to 31.12.2005 was used for the validation. Results from the Tank model can also obtained using the monthly data also depends on the requirements of the accuracy of the results.

C. Model Description

Tank model was originally developed and introduced by Sugawara in Japan in the year 1967 and it was popular in the Japan only but later on the model was used in the different parts of the world and now this is the most important, well known and user friendly model in the field of rainfall runoff modelling. The concept of the model is very simple.

There are four tanks vertically laid in series are the parts of Tank model as shown in the above figure. The model is very simple to understand. Side outlets of the tanks are for the calculation of the runoff from the same tank and the bottom outlets are for the calculation of the infiltration of from the same tank. Precipitation is added in the top tank and the evaporation is subtracted from the top tank onwards. The output from the top tank is considered as the surface runoff but the output from the second runoff is considered as the intermediate runoff, Output from the third tank is considered as the sub base runoff and the output from the bottom tank is considered as the base flow. The behaviour of the Tank model is nonlinear so the effect of the initial loss of precipitation is not considered as I is already taken in the account.

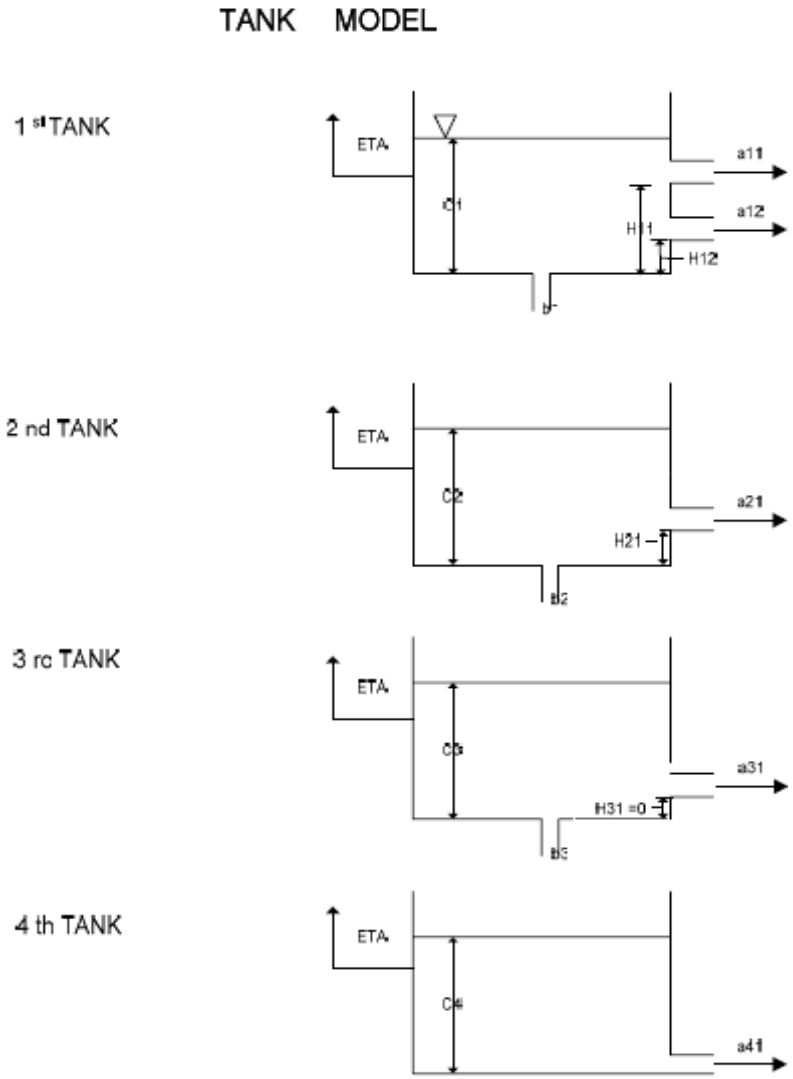

Fig. 1 Description of Tank model

Table I Parameters of TANK Model

S. No.	Values of different parameters		
	Parameters	**Default minimum**	**Default maximum**
1	a11	0	1
2	a12	0	1
3	a21	0	1
4	b1	0	1
5	b2	0	1
6	C1	0	100
7	C2	0	100
8	C3	0	100
9	C4	0	100
10	H11	0	500
11	H12	0	300
12	H21	0	100
13	H31	0	100
14	H41	0	100

III. RESULTS AND DISCUSSION

The Tank model was set up for the Narmada Upper basin of the Central India for GDQ site at Dindori, the area of basin considered in the study was approximately 2292 square kilometres. Calibration of the model was done with the data from 1.1.2000 to 31.12.2003 and the validation of the model was done with the data from 1.1.2004 to 31.12.2005. The coefficient of determination value $(R)^2$ for the calibration was found is 0.8191 and the scattered plot between the observed runoff values and the simulated runoff values from the tank model is as follows

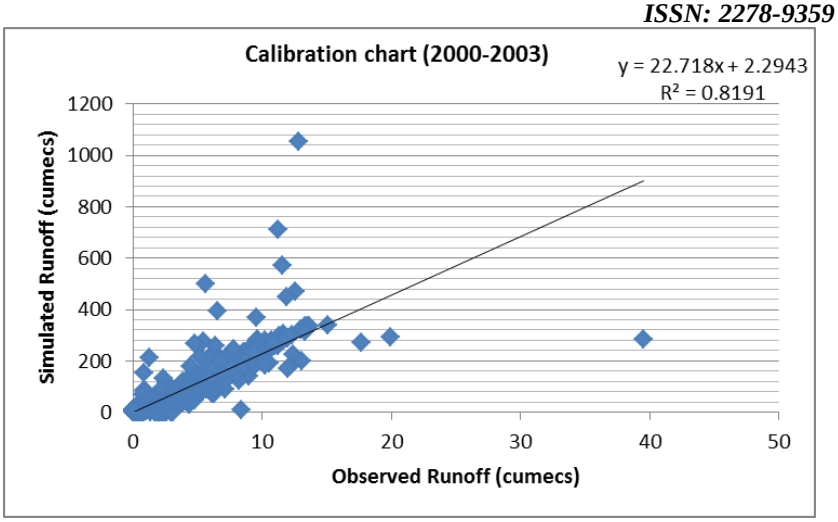

Fig.2 Calibration chart

And the Coefficient of determination value or R^2 values for the validation (1.1.2004-31.12.2005) was found as 0.6972 and the scattered plot between the observed runoff values and the simulated runoff values obtained from the tank model was found as follows.

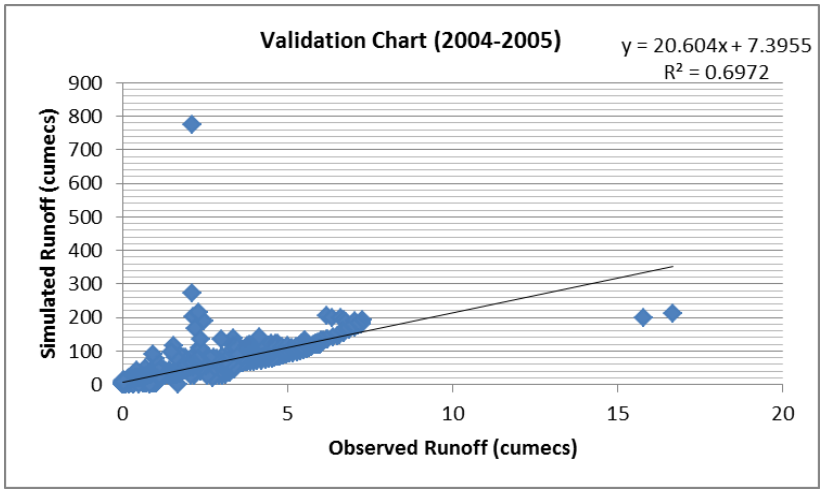

Fig.3 Validation chart

IV. CONCLUSIONS

The Tank model used for the Rainfall Runoff Modelling for the Narmada Upper Basin was found suitable with the Coefficient of determination values (R^2) for the calibration and validation were 0.8191 and 0.6972 respectively. So from the present study it can be concluded that the Tank model is applicable for the selected area and the model is suitable for Indian basins for the estimation of the runoff..

REFERENCES

[1] Sugawara, M., Watanabe, E. Ozaki, E., and Katsuyama, Y. Tank model with snow component. The National Research Center for Disaster Prevention, Science and Technology Agency, Japan, 1984.

[2] H. Basri, " Development of Rainfall-runoff Model Using Tank Model: Problems and Challenges in Province of Aceh, Indonesia", *Aceh International Journal of Science and Technology, 2 (1),* pp 26-36, April 2013.

[3] Phien H.N. and Pradhan P.S.S., "The tank model in rainfall-runoff modelling", Asian Institute of Technology, Bangkok, Thailand, vol. 9, July 1983.

[4] Ramasastri K.S., "Simulation of daily runoff in a mountainous catchment using the Tank model", IASH no 193, pp 623-626, Aug 1990.

[5] Datta B, "Runoff analysis of two Indian Basins using Tank model", Research note 5, National Research Centre for disaster prevention, Japan, 1984.

