降雨—流出概念モデルの同定
—計算時間ステップがモデルパラメータに与える影響について—

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Calibration of A Conceptual Model
— Effect of Time Step Size of Parameter Values —

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Abstract

The conceptual models are used for a variety of purposes ranging from extension of discharge data series to flood forecasting. The terporal resolution of input precipition data usually varies from one-hour to one-day. This resolution of input data may affect the optimum parameters for the catchment due to the averaging effect. This aspect has been examined in this paper.

Key words : conceptual model, experimental basin, calibration, modelling, time step
キーワード：概念モデル，流出試験地，同定，モデル化，時間ステップ

1. Introduction

The conceptual models were developed to model small homogeneous areas. However, they been successfully applied to basins having wide wariations in topography and vegetation and catchment area of the omder of thousands of sq. km. The input data

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requirements for these models can be easily met with. Ciriani et al (1977) and Blackie & Eeles (1985) give a lucid discussion on philosophy and applications of these models.

The purpose of this paper is to investigate the impact of temporal resolution of input data, particularly rainfall, on the optimum parameters of a conceptual rainfall-runoff model. A simple conceptual model has been used to simulate the basin response. This model has been successfully used to nimulate the cydrologic response of a number of catchments including the Urajiro experimental catchment of NIED, see Jain and Kishii (this issue).

2. Study area and data used

The data of Kolar subbasin of the Narmada basin, located in central India, were used in this study. The Kolar basin is located in the latitude range of 22° 40' to 23° 08' and longitude 77° 01' to 77° 29'. The catchment has elevation varying from 600m to 300m. The data pertaining to the catchment area of 820 sq. km. up to the Satarana gauge & discharge measurement site were used. The index map of the basin is given in Fig. 1.

For Kolar catchment, the hourly rainfall data at four stations were available for the period 1988-88 and were used to get weighted average hourly rainfall. The hourly discharge data for monsoon season only were available at the Satrana station. The pan evaporation dfta for a station located near the basin in agricultural area were used to obtain potential evaporation.

3. Parameter estimation

Out of the ten parameters, four are time constants of various reservoirs which do not affect the monthly volume of the simulated hydrograph (except the time constant of the groundwater reservoir) and hence need not be calibrated in the first stage. Therefore, in this study only six parameters, namely S_{max}, C_{max}, FC, FINF, C_{max}, Ewf and K_G were optimized. The Rosengrock mothod, which is a search technique, was used for optimization. The following objective function was adopted

$$\text{Min } Z = \Sigma (VO_t - VS_t)^2 \quad \cdots (1)$$

where,

VO_t = Volume of observed hydrograph in mm for month t,

VS_t = Volume of simulated hydrograph in mm for month t.

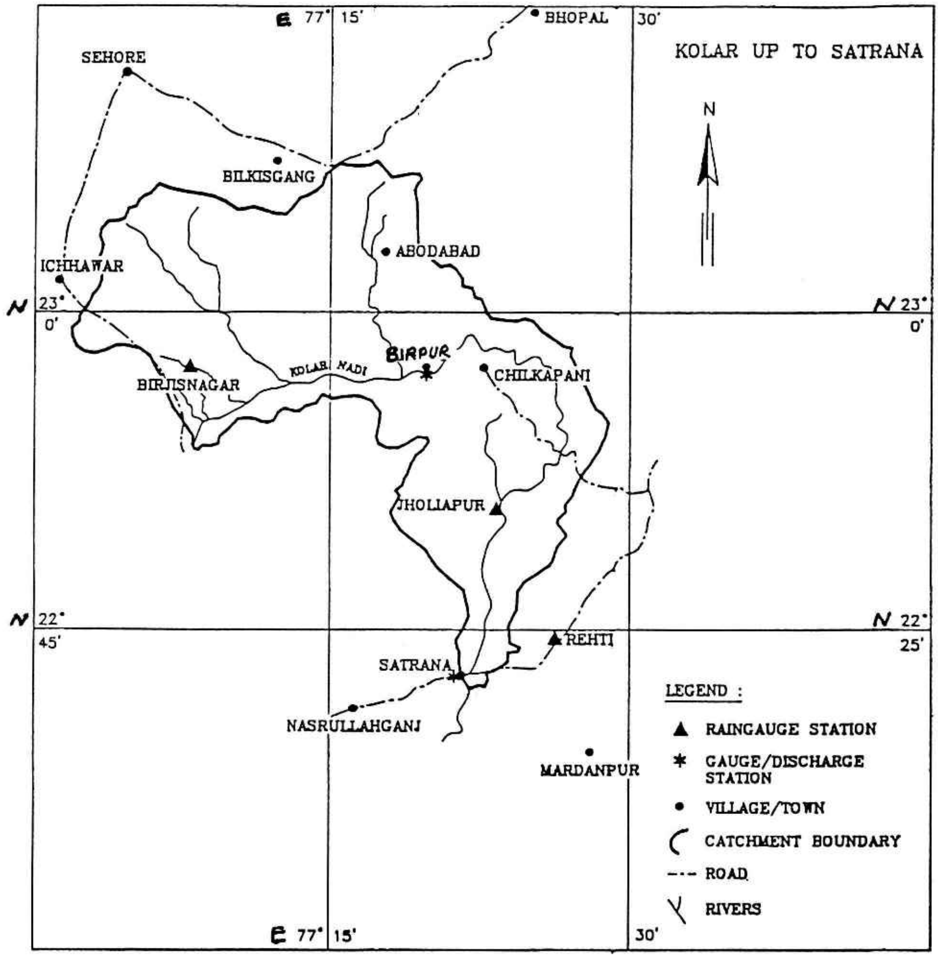

Fig. 1 Index map of Kolar catchment up to the Satrana Gauging station.

Table 1 Optimum Parameter Values Corresponding to Different Values of dt for Kolar Catchment

Para meter	dt=							
	1-hr	2-hr	3-hr	4-hr	6-hr	8-hr	12-hr	24-hr
Smax	76.25	75.97	76.06	77.50	76.25	78.50	77.94	69.50
Cmax	388.75	378.75	378.75	366.56	373.75	367.50	363.75	371.88
FC	0.4875	0.5664	0.5594	0.4469	0.5734	0.5500	0.5594	0.5687
Finf	0.8594	0.8695	0.8968	0.9047	0.8219	0.8359	0.8102	0.7938
Cint	0.7500	0.6375	0.6375	0.7125	0.6000	0.6375	0.6000	0.5625
Ewf	0.1734	0.2547	0.2500	0.1734	0.2875	0.2500	0.2695	0.3188
Obj Fun	17477	17950	18059	18107	18587	18716	19232	19294

4. Results and discussion

The optimum model parameters were determined using the average hourly rainfall, daily potential evaporation and volume of discharge hydrograph on a monthly basis. A number of optimization runs were taken in which different values of time step-size (dt) were used. The rainfall intensity was averaged over the time-step. For instance, if the time-step size is 6-hours, the average of rainfall rate over a period of six-hours is used as input. Therefore, except the input rainfall rate, all other conditions are same in various runs. The values of dt which were considered in this study are : 1, 2, 3, 4, 6, 8, 12, and 24 hours. The values of optimum model parameters corresponding to various values of dt are given in Table 1.

It is seen in the Table 1 that the parameters S_{max} and C_{max} do not vary too much with dt and the parameter FC is varying by about $+10\%$ to -10%. The variation in F_{inf} is quite small. However, the parameters C_{int} and Ewf show significant variations. The variation in the parameters in somewhat sharp when dt changes form 12 to 24 hours. However, the parameters do not show any definite trend of change. Some variation in the parameters may be explained by the fact that the parmeters do compensate for each other. The value of objective function increases with dt though the increase is slow. This may mean that the fit is becoming poorer with increase in dt possibly because some information in being lost consequent to averaging. The objective function appears to be quite flat near the optimum.

Since the CPU time required to obtain the optimum model parameter for a particular basin largely depends on dt, the modeller may use a bigger value of dt and obtain comparable results. In case where eventually a smaller time-step size is required, the first few runs can be taken with a larger time-step size to arrive near the global optimal parameter set. Next, the optimum parameters corresponding to the requisite (smaller) dt can be taken.

In many cases, historical rainfall data are available on daily basis. It is clear from the above that these data can be used to obtain a reasonably good entimate of the model parameters. These parameters can be confidently used to estimate the catchment yield and also the shape of the discharge hygrograph if the size of the catchment is not small.

5. Conclusions

The conceptual mathematical models are commonly used for rainfall runoff modelling of a catchment. The impact of temporal resolution of input rainfall data on the optimum model parameters for a basin has been discussed. It was found through numerical experimentation that the optimum parameters for a particular catchment do vary with the time resolution of the input rainfall data though the variation in not very large. Further, no definite trend of the parameter variation was found.

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