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Stream Flow Modelling of Sri Lankan Catchments (2)

——Kalu River Catchment at Putupaula——

スリランカの河川流域の流出機構のモデル化（2）

——カル川について——

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1 Introduction

In this second part, the stream flow modelling of Kalu river basin (at Putupaula) is presented. The Kalu river is in the western part of Sri Lanka which is considered as the wet region. This river also starts from the central hills and flows to the sea at Kalutara (Fig. 2.1) .The catchment area at Putupaula is approximately 2598km^2. Rubber plantations cover about 35% of the area while paddy area and home steads reach to about 15% and 20% respectively. Kalu river has not been subjected to any major development works and hence is a virgin catchment. In this study, the simulation of streamflow at Putupaula gauging station using daily rainfall data collected at six stations (from 1977-1980) is presented. In this basin also daily pan evaporation data of two stations (from 1978-1983), the topographic and land use maps were available (Fig. 2.1).

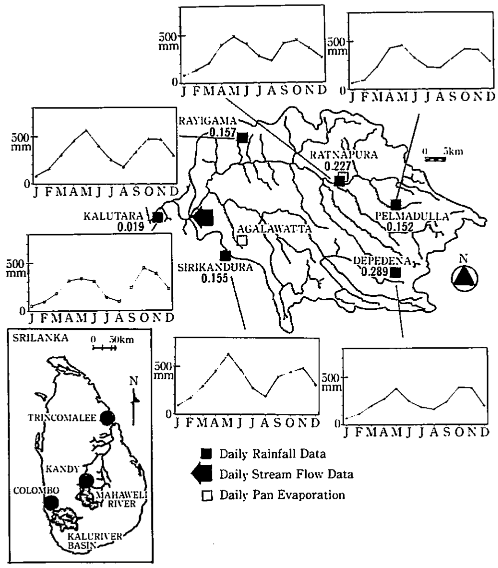

Fig. 2.1 Monthly Average Rainfall and Optimised Rainfall Station Weights

2 Model Application and Modification

Observed hydrographs for Kalu river basin showed attenuated peaks when the discharge is above 10mm/day (300m^3/s) which reflected the possibility of flooding in the catchment. Low flow fluctuations in the hydrograph showed sharp increases and decreases indicating possible errors in data. The statistical tests and the double mass curves showed the data to be homogeneious but lack of additional information than that stated earlier prevented any further verification. The data set in the same status was used for analysis.

The calculations for the Kalu river were also based on the same computer programme which was used for the river Mahaweli where a cyclic procedure was used to optimise the parameters (described in part 1). The parameter optimisation technique and the paprameter estimation criteria were the same as described in Part 1. The seasonal pattern of pan evaporation values of the two stations were used to obtain the evaporation indices.

Initially, the simple tank structure with four tanks was used in the calculations. Five rotational calculations using the data set resulted stable storages in the respective tanks and as in the case of the Mahaweli basin these were used as initial storages. Data from 1972-1975 were used for model calibration and the period 1976-1979 was taken for verification. Parame-

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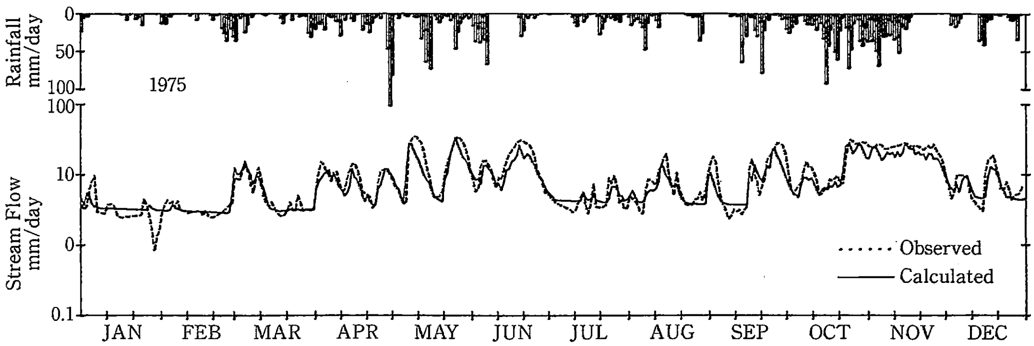

Fig. 2.2 Calculated and Observed Hydrographs with a Simple Four Tank Model

ter optimisation by trial and error with improving initial parameters was carried out in a manner similar to the previous basin and the performance of the model during optimisation was similar.

Results using the simple tank structure with spatially varied rain showed a value of 0.2451 for the ratio of absolute error to mean. The graphical comparison showed that the matching of calculated and

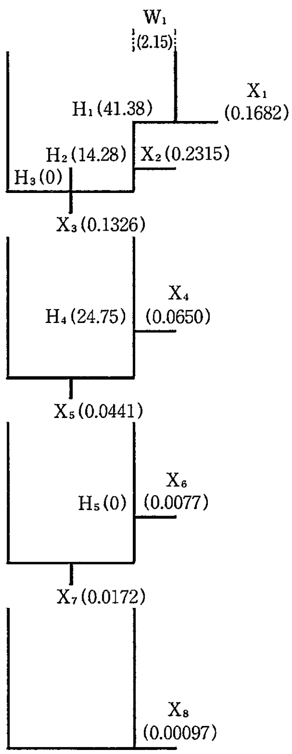

Fig. 2.3 Modified Tank Structure to suit Flooding in the Catchment and the Optimised Tank Parameters

observed outflows during the estimation period was not very satisfactory as the outflow predictions by the model showed sharp peaks (Fig. 2.2) whereas the observed hydrograph had attenuated peaks. The paddy lands in the Kalu river catchment which are on both sides of the river act as retarding basins storing considerable amounts of rain water. In addition, the awareness of heavy flooding in the Ratnapura area of the catchment lead to the necessity of modifying the tank structure to suit flooding. In the case of flooding, the river stage rises and occupies its banks increasing the channel section thus causing the flood peak to lose its sharpness. This effect was incorporated to the top tank of the model in order to treat the attenuation of peaks (Fig. 2.3). In this modification the increase in the top tank width was treated as a parameter to be optimised. The annual streamflow and rainfall showed a more uniform variation during 1976-1979 period and this period was taken as the estimation period in the subsequent calculations.

The results of the estimation with the new data set showed improved flow predictions close to the peaks and also in the recession parts of the hydrographs (Fig. 2.4). The model calculations using uniform rainfall had an absolute error to mean of 0.2761 and this was improved to 0.2667 with the inclusion of the spatial variability of rain. Though it was clear that the top tank expansion was too sudden, further attempts to modify the model was set aside until the data could be checked further by inquiring from the source. The calculated and observed hydrographs for the verification period with spatially varied rain is shown in figure 2.5. Optimised rainfall gauging station weights and the spatial variation of rainfall in

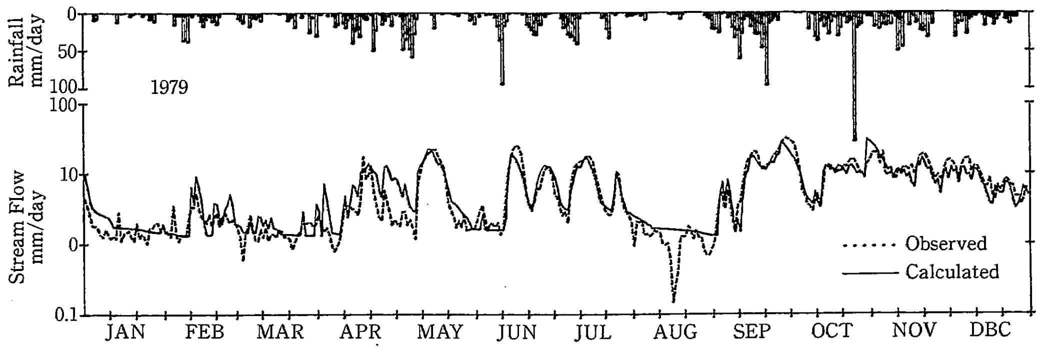

Fig. 2.4 Calculated and Observed Hydrographs during Calibration (Using the Model Modified for Flooding)

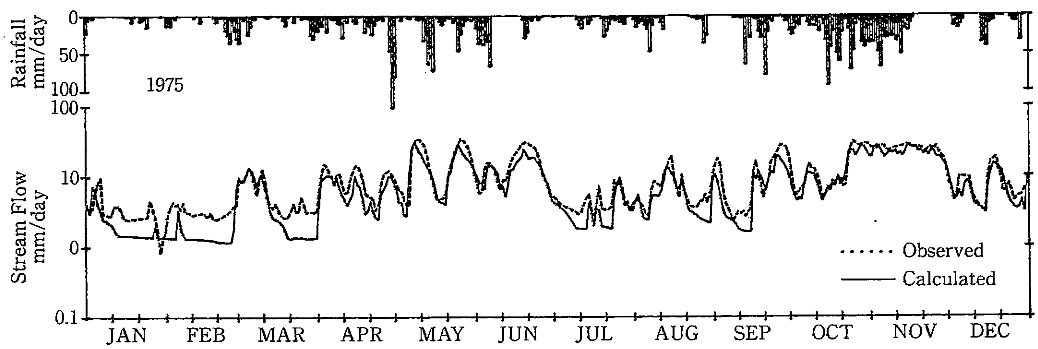

Fig. 2.5 Calculated and Observed Hydrographs during Verification (Using the Model Modified for Flooding)

the catchment are shown in Figure 2.1.

3 Concluding Remarks

Streamflow modelling of the Kalu river basin in Sri Lanka using the same methodology described in the Part 1 is presented. The introduction of the flood tank provided improved flow predictions and hence reflects the possibility of modifing the model structure to reflect the physical representativeness of a basin. In the case of this basin also the inclusion of non uniformity of rain improved the model predictions but very marginally. This may be due to the errors in data or due to the inadequacy of the model in representing the catchment. The optimised parameters are acceptable with the rainfall distributions and the locations of rainfall stations.

4 General Comments

The tank model which has been widely used for Japanese river basins showed satisfactory results in the case of Sri Lankan basins. However, response of the Kalu river basin which had a higher spatial variation of rainfall was comparatively low. Kalu river basin shows a high spatial variation in both monthly and annual rainfalls whereas Mahaweli basin shows a significant spatial variation only in monthly rainfalls.

Mahaweli river basin (at Peradeniya) has a mountainous terrain while Kalu river basin is hilly. The Mahaweli river basin is at a higher altitude and the average temperature of the basin (at Peradeniya) is lower than the Kalu river basin. The more uniform behavior of the Mahaweli basin under study may be due to the landscape and the altitude. Therefore the Mahaweli basin at Peradeniya may not be categorised as a typical tropical catchment eventhough Sri Lanka is in the tropical region. The smooth behavior of the model in the Mahaweli catchment could produce improved results with the introduction of the spatial variability of rain, while this effect could not be highlighted in the case of the Kalu river basin. This could be due to the possibility of errors in data and the model inadequacy in the representation of a tropical catchment.

The Parameter optimisation technique used was fast, even with the adoptation of a trial and error technique. Evaporation has only a marginal effect on the model calculations and the method used for calculating the evaporation indices showed to be adequate. As the accuracy of data is the key to forming a good model, it is quite important to check the data before and while modelling. The rainfall averaging method used for these studies is different from the conventional methods in which weights are not optimised along with the model parameters. In the case of these two basins the optimised parameters appear to be acceptable when compared with the spatial variation in annual rainfall.

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