Runoff Analysis of the Lower Mekong Basin Using Tank Model

タンクモデルによるメコン河下流域の流出解析

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Introduction

Flooding of Mekong River causes serious damage to agricultural production, human settlements and rural infrastructures in the deltaic area of Cambodia every year. For delineating the flood inundation in the whole deltaic area, runoff analysis of Mekong River is crucially important. In this study, for the first step of inundation analysis, runoff modeling of Mekong River using Tank Model was carried out in order to estimate the amount of inflow to the deltaic area. The study area is the lower Mekong basin from Pakse to Kompong Cham with 101,885 km^2 of drainage area (shown in Fig.1). The whole study area was divided into 9 sub-catchments (I to IX) based on the distribution of tributaries and stream gage stations.

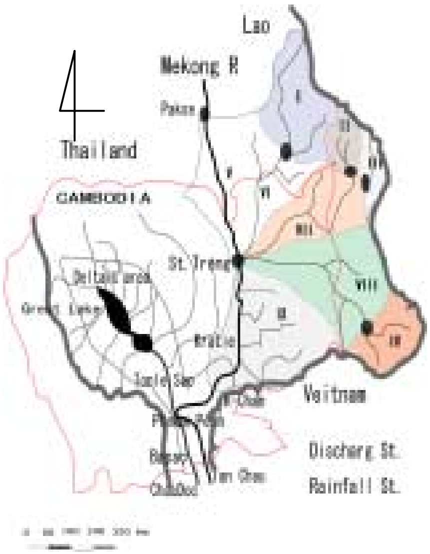

Fig.1 Mekong Delta Study

Data collection and analysis

Such hydrologic data as daily rainfall, discharge and pan evaporation were collected from the Lower Mekong Hydrologic Year Books for 1995-1997. Areal average rainfall of each sub-catchment was calculated based on Thiessen polygons method.

Water balance was analyzed before the runoff modeling. Discharge at Steong Treng, which consists of 8 sub-catchments (I to VIII), the corresponding rainfall and pan evaporation were compared on monthly basis and yearly basis. The result of this analysis showed that the relation between rainfall and discharge data was reasonable and actual ET was estimated to be about half (0.5) of pan evaporation.

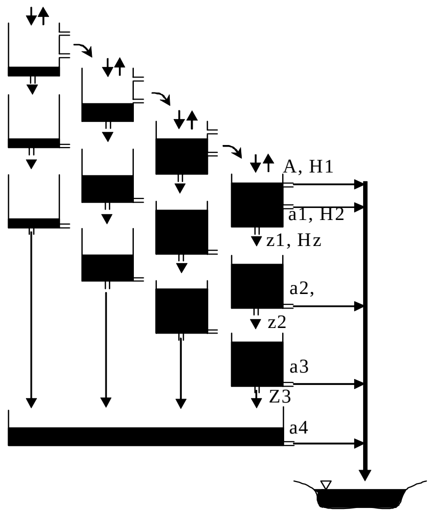

Fig 2. Series Tank Model

Model Configuration

Sugawara (1972) proposed 4×4 Tank Model for watersheds having an intense dry season. However, according to Tatano's application (1999) of 4×4 Model had a tendency that stored water in the lowest tank of the nearest column to the river goes on increasing too much. Hence, Tatano modified the model structure to a model system with 3×4+1 tanks (shown as Fig.2) and obtained a good result from the modification. The 3×4+1 tank considers the deep ground water as one tank so as to prevent ground water from gathering in the closest zone to the river too much. One 3×4+1 model was applied to each of the 9 sub-catchments. Figure 3 shows the schematic feature of the whole watershed modeling. Out of the 9 sub-catchments, 6 sub-catchments are determined have gauging stations of out flow discharge from them.

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Since the other 3sub-catchments (VI,VII, VIII) have no discharge data for calibration, the parameter sets of these sub-catchments are determined as the same set jointly with the sub-catchment V (T-5), while model calibration for each of the 5 sub-catchments (I to IV and IX) is done individually.

Results and Discussion

Model calibration was done for the year 1995 through trial-and-error approach, and the data for the year 1996-1997 were used for model validation. For connecting sub-catchment models, the calculated discharges were used as inflow into the lower sub-catchment. The obtained hydrographs are presented in Fig.4. The calibrated parameter values and model performance are summarized in Table 1. In this stage, the model calibration does not contain the channel routing process, therefore the parameter values for T-5 and T-9, where channel routing influences the hydrograph largely, are tentative ones. These parameters will be calibrated again after incorporating the channel routing process in the model. Though the mean relative error becomes a little higher in the validation period, the overall degree of agreement between the calculated and observed hydrographs is considered well satisfactory for this stage. Hence, the 3×4+1 model is considered to have a capacity of representing the watershed properly and to be used as an effective toll for estimating inflow to the inundation area.

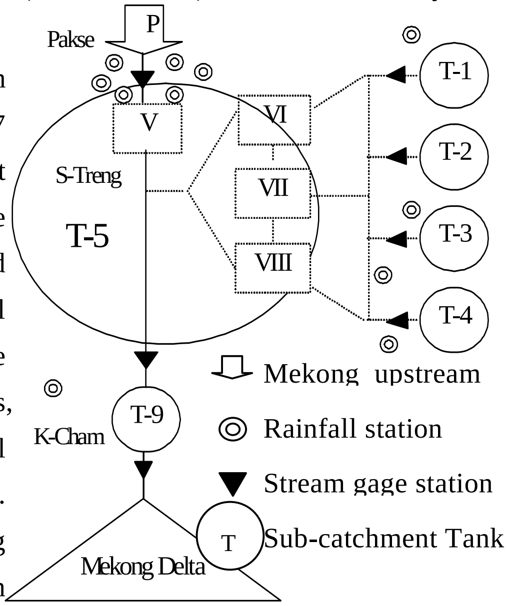

Fig. 3 Schematized Modeling Areas

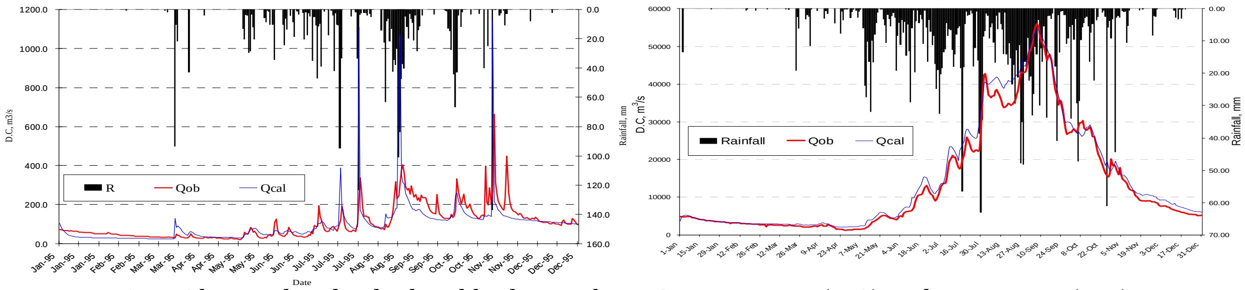

Fig.4 Observed and calculated hydrographs at Stoeng Treng (T-2) and at Kontum (T-5)

Table 1: Rainfall-Runoff Parameters

Sub-catchment	T-1	T-2	T-3	T-4	T-5	T-9
Area(km^2)	14770	3505	3593	8626	47797	23594
Upper overland flow coefficient	0.3	0.3	0.3	0.31	0.0014	0.0013
Max.water content in surface zone(mm)	15	25	35	25	30	35
Infiltration coefficient in surface zone	0.5	0.55	0.6	0.6	0.75	0.7
Max.water content in root zone(mm)	35	70	80	60	60	60
Root zone runoff coefficient	0.021	0.025	0.013	0.025	0.000002	0.000004
Max. water content in lower root zone(mm)	180	250	250	170	200	210
Lower root zone runoff coefficient	0.0043	0.0025	0.002	0.0035	0.000002	0.000002
MRE-Calibration period (1995)	0.44	0.33	0.33	0.30	0.2	0.25
MRE-Validation period (1995)	0.52	0.45	0.43	0.36	0.2	0.3

MRE: mean relative error.

Reference:

1. Tatano, M (1999). *Real-Time Flow Forecasting in Midstream Basin of Mekong River by Combining a Deterministic Runoff Model with a Stochastic Model*. Master Thesis, Utsunomiya University.
2. Matsumoto, T (2000). *Modeling with of multi-function hydrologic roles of Tonle Sap and its vicinities*. Technical Support Division of Mekong River Commission, MKG/R.00017