Hydrologic Analysis on Inundation in Mekong Delta, Cambodia
カンボジア領メコンデルタにおける洪水氾濫解析

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1. Introduction

The Mekong River shows high seasonal variation in water level (or discharge flow rate) between the dry season and the rainy season, and it causes heavy inundation in the Delta area along the river every year. For identifying the properties of the inundation, the present study aims at establishing the following three models as the basic models: 1) Mekong River runoff model; 2) Tonle Sap Lake model; and 3) Delta water balance model, which can represent the inundation process in the Delta. The whole area to be studied is shown in Fig.1. The interrelation among the three models is presented in Fig. 2.

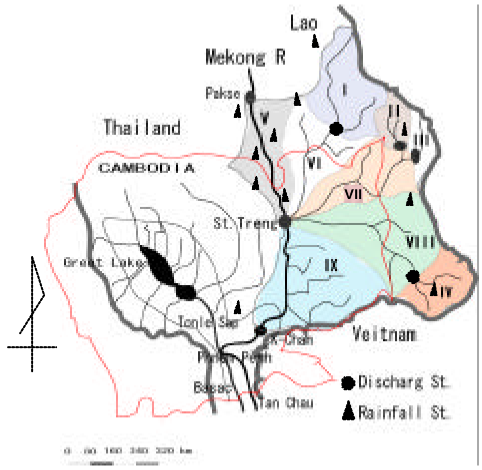

Fig. 1: The Study area of Mekong Delta

2. Model establishment and simulation results

Mekong River runoff model: The 3*4+1 type Tank Model with a channel routing sub-model (Tatano, 1999) was employed to calculate the runoff from the 116,199 km^2 of drainage area of Mekong River from Pakse to Kompong Cham. The whole drainage area was divided into nine sub-catchments and one Tank Model was applied for each sub-catchment. Since three sub-catchments (VI, VII and VIII) out of the nine have no stream gauge station at their outlets, the model parameters were assumed as same values as those of sub-catchment V.

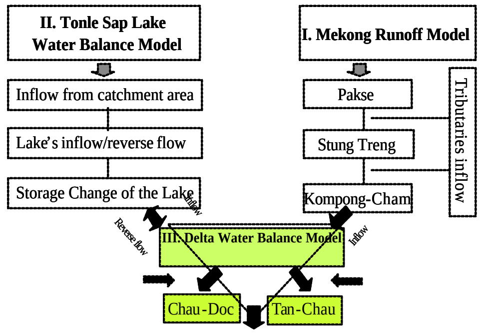

Fig. 2: Relationship among the three models

Model calibration was done for the year 1995 through trial-and- error approach, and the data for 1996-97 were used for model validation. The obtained hydrograph at Kompong Cham (IX) is presented in Fig.3, and the parameter values and model performances are summarized in Table 1.

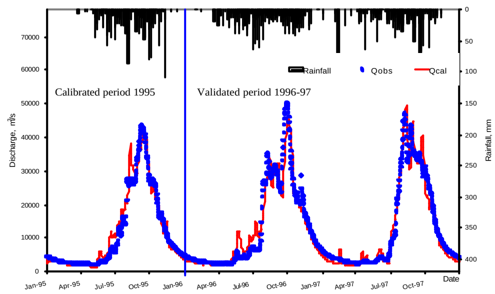

Fig.3: Hydrographs at Kompong Cham (IX)

Tonle Sap Lake model: The Tank Model was first applied for the calculation of inflow from two rivers (Pursat and Sen), where daily data records of discharge and rainfall for the same period are available. Based on the result of regression analysis between the total inflow and discharge from the two rivers, the total inflow from the catchment was estimated by the 3*4+1 Tank Model. Calculation of outflow or reverse flow through Tonle Sap River was formulated based on the channel's cross-section and the water levels at the lake and at the downstream of Tonle Sap River. The relationship curve between water levels and storage volumes was established from a DEM analysis. The storage change was calculated from the water balance of the lake, and it was converted to daily change in water level.

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Table 1: Parameter values of the Mekong Runoff Model (MRE: mean relative error)

Sub-catchment	I	II	III	IV	V	IX
Area, km^2	14796	3267	3613	9570	47797	23594
Upper overland flow coefficient (B1)	0.230	0.310	0.240	0.280	0.570	0.56
Upper overland flow coefficient (A1)	0.220	0.280	0.210	0.270	0.560	0.55
Infiltration coefficient in surface zone (Z1)	0.250	0.300	0.300	0.330	0.050	0.05
Root zone runoff coefficient (A2)	0.023	0.035	0.022	0.028	0.070	0.05
Infiltration coefficient in root zone (Z3)	0.020	0.010	0.018	0.015	0.001	0.01
Ground water runoff coefficient (A4)	0.0001	0.0001	0.0001	0.0001	0.00001	0.00001
n manning's roughness coefficient	0.003	0.003	0.003	0.003	0.006	0.007
Channel width, (Bc,m)	100	100	100	100	1300	1500
MRE-Calibration period (1995)	0.48	0.35	0.28	0.24	0.22	0.23
MRE-Validation period (1996-97)	0.59	0.45	0.62	0.55	0.29	0.25

Figure 4 presents the results of water balance of Tonle Sap Lake and Figure 5 shows the calculated water level change in comparison with the observed values.

<ins>Delta water balance model (DWBM)</ins>: The whole delta was divided into four zones (SD-1 to SD-4) and each zone was considered as a storage reservoir. Flooding water from the main river was calculated from the zone's water level and the main river's water level using formulas for channel flow and weir flow. Return flow was also calculated in the same way. The storage change of the delta zone was calculated from water balance, and it was converted based on the relationship between storage volumes (V) and water levels (H). For the calculations of flooding inflow and return flow, due to the lack of field data, assumed values for the parameters were examined and calculation was iterated to make the final result a reasonable one. Validity of the V-H curve was also examined in the same iteration process. These procedures are shown in Fig. 6. Figure 7 presents the calculated water level of the zone 3 finally obtained, in comparison with the observed water levels at Phnom Penh and Chau Doc.

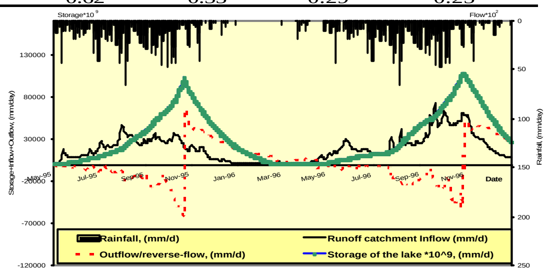

Fig. 4: Water balance of the Lake

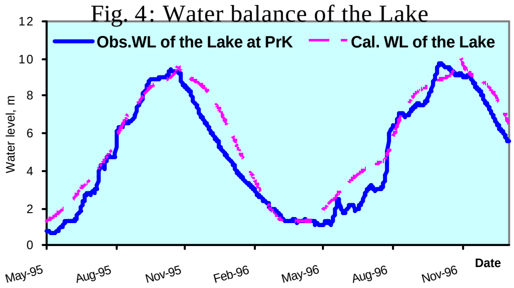

Fig.5: Comparison of water level

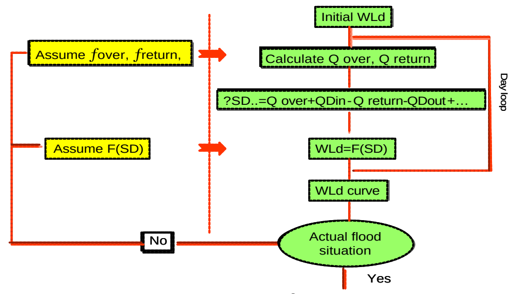

Fig.6: The procedure of DWBM

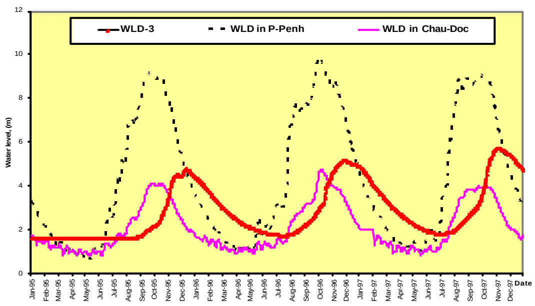

Fig.7: Calculated water level in SD-3

3. Conclusions

The Mekong River runoff model and the Tonle Sap Lake model were established with satisfactory results. They are considered to have capacity of estimating inflow to the Mekong Delta. The Delta water balance model was also established, though the performance of the model could not be tested due to insufficiency of necessary data records. These three models are considered to provide the basic frame for modeling the Delta inundation. For more accurate modeling of the Delta water balance, it will be crucially important to collect detail data on topography as well as water level records.

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.
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