Runoff Analysis of Prek Thnot River Watershed, Cambodia

カンボジア・プレックタノート川流域における流出解析

○ **Sam Chhom Sangha*, Akira GOTO**, and Masakazu MIZUTANI****

1. Introduction

Prek Thnot River is one of major tributaries of Mekong River in Cambodia, whose watershed has high potential in water resources development to increase agricultural production. It occupies 5,000 km^2 of the total area of Kompong Speu province with existing 43 irrigation schemes **(Fig. 1)**. Most of them were constructed during 1975-1979 with improper planning that resulted in low yield of agricultural production. If the irrigation planning is conducted properly, irrigation areas will increase and the cropping intensity will be doubled for all schemes. So, an assessment of spatial distribution of water availability in the watershed is necessary. Irrigation practices will strongly affect the river flow, and such influences must be assessed too when the irrigation schemes are rehabilitated. For these purposes, a distributed hydrologic model plays a significant role in these issues. Meanwhile, river flow runoff is largely influenced by actual evapotranspiration (ET) in the watershed having a distinct dry season. An accurate estimation of actual ET is crucially important for proper watershed modeling. Therefore, the final objectives of this research are i) to establish a distributed system hydrologic model by combining a distributed hydrologic model and an evapotranspiration (ET) sub-model, and ii) to apply a distributed model equipped with ET sub-model in order to assess the spatial distribution of the water availability in the watershed and effects of irrigation activities on the river flow regime. In this report, for the preliminary step to the final goal, adequacy of the available data of the watershed was examined through simple Tank model application.

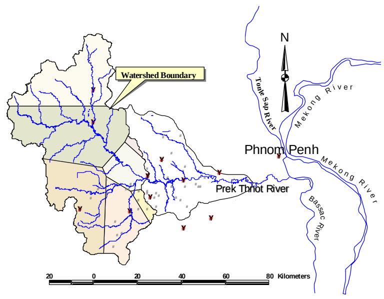

Fig.1 Location map of Study Area

2. Water balance analysis

Available hydro-meteorological data for three-years (2001–2003) were collected. Discharge data were available only at Peam Khley station which is near the planned dam site. Meteorological data at Pochentong station which is the nearest station from the watershed and rainfall data at seven rain gage stations within the watershed were used to analyze potential evapotranspiration and average areal rainfall respectively.

Table 1 Water balance at Peam Khley station

Catchment Area = 3,650 km^2			
Description	Year		
	2001	2002	2003
Rainfall (mm)	1520.92	1092.73	1431.02
Discharge (mm)	569.71	153.65	461.74
Eta + △S (mm)	951.21	939.08	969.29
Eto (mm)	1612.13	1690.29	1874.13

Thiessen Method was used to calculate an average areal rainfall of the watershed (**Fig.1).** FAO Penman Monteith equation was adopted to estimate potential evapotranspiration. Annual water balance was analyzed as shown in **Table 1**. It indicates that annual actual ETa is estimated about halt of the annual potential ETo. The relation among rainfall data, discharge data and ETa is considered to be reasonable. Therefore, these data can be used for runoff analysis.

*Graduate School of Agricultural Science of Utsunomiya University, **Utsunomiya University

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3. Tank model application

Table 2 Tank model parameters

Tank	1	2	3	4
B	0.003	0.3893	0	0
HB	283	32.5	0	0
A	0.04	0.067	0.0014	6.5E-05
HA	125	22.8	0	0
Z	0.183	0.1485	0.0120011	1E-05
HZ	0	0	0	0
XHini	0	6.3	135	956

Table 3 MRE and ME values

Year	2001	20001	2003
MRE	0.12	0.19	0.20
ME	0.83	0.61	0.70

The simple Tank Model (Sugawara M. 1961) that consists of 4 storage tanks was applied to calculated runoff at the outlet of the upper catchment in this preliminary analysis. Model calibration was done for the year 2001 through trial and error approach, and the 2002-2003 year data were used for model validation. The obtained hydrograph is presented in **Fig.2**. **Table 3** gives the Mean Relative Error (MRE) and Model Efficiency (ME) for calibration and validation periods. Most of MRE values are less than 0.20 and the values of ME are above 0.60 for the simulation years. The calculated discharge by this model showed fairly good agreement with the observed one. The correspondence between hyetograph and hydrograph shows that the observed data are reliable and can be used for further model establishment.

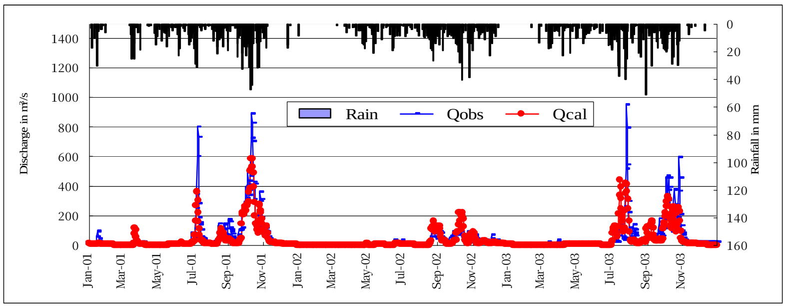

Fig. 2 Hydrograph at Peam Khley station

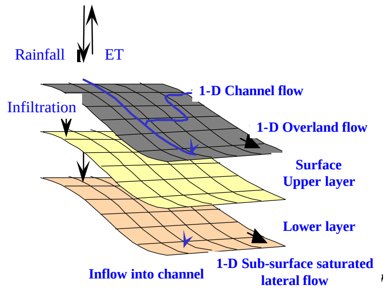

Fig. 3 Sketch of water movement (Mohammed A. *et al*, 2002)

4. Future Plan

Many hydrological models have been developed to serve various purposes. In term of Lumped model, the flow is calculated as a function of time alone and it cannot predict the changes of land use, while distributed system hydrologic models, which the flow is calculated as a function of space and time throughout the system, can predict hydrological effects by manmade changes land use and other water use. In this research, Mohammed's model (Mohammed A. *et al* 2002) which is composed of interception, infiltration, evapotranspiration, overland flow, channel routing and sub-surface saturated flow will be employed. The model is a two-layer, continuous, distributed-parameter and watershed-scale model as shown in **Fig.3**

Sakai's ET sub-model (Sakai *et al* 1994) will be employed to this study. The parameters of the ET sub-model are determined by soil types and vegetation types. The ratio of evapotranspiration to potential evapotranspiration is calculated by average water content of a certain depth of soil layer corresponding to the root depth of plants. Consequently, a curve to present the relation between evapotranspiration ratios and water contain ratios can be obtained for each of given conditions of soil and vegetation types. Thus, the ET sub-model is able to estimate actual daily evapotranspiration from the present storage level and the input potential evapotranspiration.

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