Improvements of the runoff model for Cidanau watershed, Banten Province, Indonesia
インドネシア・バンテン州チダナウ流域における流出モデルの改良

〇Arien Heryansyah*,　A. Goto**,　and　Yanuar M.***

Introduction

The integrated watershed management, which aims at restoration of a sound hydrologic regime in the watershed considering water resources utilization, appropriate land use, water quality control and environmental conservation, is becoming crucially important in such developing countries as Indonesia. Proper watershed modeling is one of the most essential parts for the watershed management. In this study, performance of the runoff model for Cidanau watershed, Banten, Indonesia, was examined by an independent calibration process and addition of observed discharge data in sub catchments.

Study Area

The Cidanau watershed (267.1 km^2) is located at 5^{o}21'-6^{o}21' South and 105^{o}7'-106^{o}22' East. Runoff discharge is observed at the intake weir near the sea (KTI Weir, 1996-2002), and Cikalumpang Weir (1999-2001). Annual rainfall in the watershed is ranging 1,641-4,172 mm and annual river discharge (in depth) is ranging 951-1,548 mm. Considering distribution of physical characteristics such as soil types, land slope, and tributaries, the watershed is divided into 6 sub-catchments (Fig. 1).

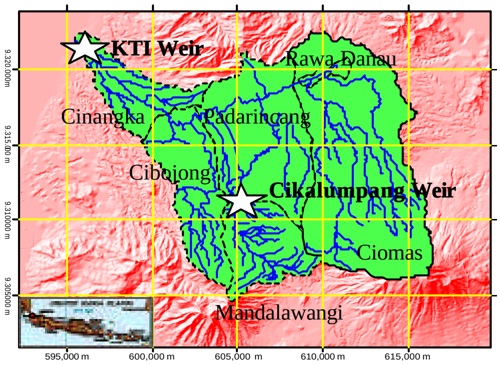

Fig.1. Cidanau Watershed

Model Configuration

The authors established a runoff model for Cidanau watershed that consists of the tanks model for slope flow and the kinematics wave equation for channel routing (Arien et al, 2003). In that model, Cidanau watershed was represented by 6 modified tank models. Each of the modified tank model consists of 5 tanks (Fig.2). As a difference from the common Tank Model, each tank has a maximum limit of water storage, therefore, water moves up to the upper tank when stored water reaches the limit. Coefficients of discharge (CR), storage capacity (X), percolation (CP) and runoff threshold (CH) of each tank are the parameters to be calibrated. In the channel routing calculation, discharge form the tank model was considered as uniform lateral inflow to the channel (Fig. 3). In this existing model, some of the parameter set for each of the 6 models were assumed the same one, except CR values. Calibration of this model was not made independenly, because it depends on result of other application manner, especially on determination of CR values.

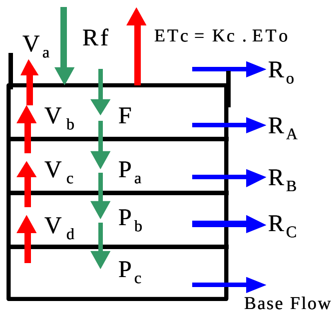

Fig. 2. Structure of tank model

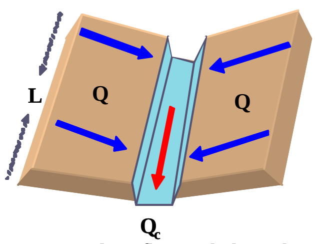

Fig. 3. Slope flow and channel routing

*United Graduate School TUAT (Utsunomiya University), ** Utsunomiya University, ***Bogor Agricultural University, Indonesia
Keywords: Watershed Modeling, Tank Model, Indonesia

Model Improvements

Two types of improvement manners were examined. In the first manner, watershed was represented by 6 modified tank models in the same way as the existing model, but the CR parameters were calibrated independently (Rev. I). For the next step, the observed data in Cikalumpang Weir was employed to Rev I, as the second manner (Rev. II). The performance of different types of improvement manners was evaluated by both of the coefficients of model efficiency (ME) and mean relative errors (MRE).

Result and Discussion

Table. 1 Performance of the Models

Model	Observed Data in KTI Weir				Observed Data in Cikalumpang Weir (1999-2001)	
	Calibration Period (1996-1999)		Validation Period (2000-2002)			
	ME	MRE	ME	MRE	ME	MRE
Existing Model	75%	48%	73%	29%	-	-
Rev. I	77%	47%	74%	30%	-81%	57%
Rev. II	76%	45%	74%	31%	51%	26%

The calculated discharge hydrograph by every model could show fairly good agreement with the observed hydrograph, at KTI Weir. The model's performances are presented in Tabel 1. Though the models has tendency of underestimation in the beginning of the rainy season, low flow pattern was reproduced well. Rev I presented best performance in term of ME and MRE at KTI Weir, but it showed very poor ME and MRE at Cikalumpang Weir. Since the existing model and Rev I did not concern about Cikalumpang's observed discharge data, Rev II was considered as the best model for replacing the existing runoff model. Even though the performance of Rev II at Cikalumpang Weir was not so good in ME, overall performance of Rev II was almost at the same level with Rev I. The hydrographs of Rev II at Cikalumpang Weir and KTI Weir are presented in Figure 4 and Figure 5, respectively.

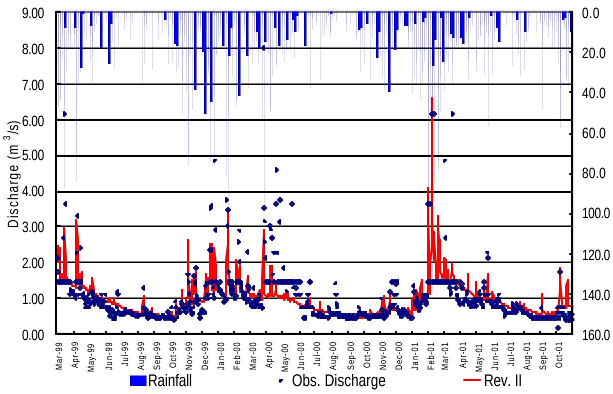

Fig. 4 Performance of Rev. II at Cikalumpang Weir

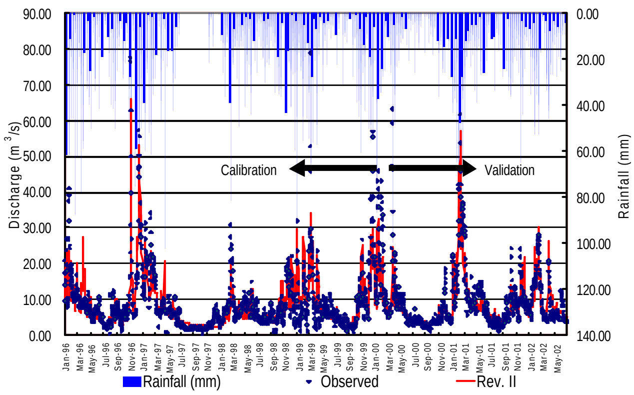

Fig. 5 Performance at Rev. II in KTI Weir

Conclusions

The results of this study are summarized as follows:

(1) The improvements of model performances were based on simplification of parameter calibration and addition of observed data points.

(2) Rev II was considered better than the existing runoff model for future research.

References

Arien Heryansyah. M Yanuar JP. Goto, A. 2003. Runoff Modeling in Cidanau Watershed, Banten Province, Indonesia. Proceeding of 2nd Seminar : Toward Harmonization between Developments and Environmental Conservation in Biological Production. Tokyo, February 15-16, 2003.

Sugawara, M. 1961. On the Analysis of Runoff Structure about Several Japanese River. Japanese Journal of Geophysics. Vol 4 No. 2. The Science Council of Japan.