MODEL PARAMETER CHARACTERISTICS OF URBAN STORAGE FUNCTION MODEL

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1. INTRODUCTION

Due to the growing population and impervious surfaces, existing sewer systems are inadequate for the handling of rainfall-runoff, which will result in serious hazard like urban flood flow. Therefore, the flood prediction in urban areas is necessary to control its harmful effects. Different models are available for the rainfall-runoff modelling in which the storage function models, one of the lumped model, have gained popularity in different parts of the world. The Urban Storage Function (USF) model is an urban-specific conceptual model which considering all the possible inflow and outflow components of the urban basin with combined sewer system and have a promising future. The ability of USF model to truly reflect the hydrological processes will mainly depend on the accuracy of the estimated parameters. Therefore, it is essential to analyze the effect of parameter characteristics on the USF model simulation for identifying the optimal parameters. Hence, we applied the USF model in the upper Kanda river basin, Japan for analyzing the effect of parameter characteristics.

2. METHODOLOGY

2.1 USF model

The USF model was developed by considering the relationship between the outflow from the basin and storage as follows:

$$s = k_1(Q+q_R)^{p_1} + k_2\frac{d}{dt}\{(Q+q_R)^{p_2}\} \quad (1)$$

$$\frac{ds}{dt} = R + I - E - O - (Q+q_R) - q_l \quad (2)$$

$$q_l = \begin{cases} k_3(s-z)(s \geq z) \\ 0 \quad (s < z) \end{cases} \quad (3)$$

$$q_R = \begin{cases} \alpha(Q+q_R-Q_0), & \alpha(Q+q_R-Q_0) < q_{R_{max}} \\ q_{R_{max}}, & \alpha(Q+q_R-Q_0) \geq q_{R_{max}} \end{cases} \quad (4)$$

where s: watershed storage (mm); Q: river discharge (mm/min); q_R: storm drainage from the basin through the combined sewer system (mm/min); t: time (min); R: rainfall (mm/min); I: urban specific and groundwater inflows from other basin (mm/min); E: evapotranspiration (mm/min); O: water intake from the basin for intended purpose such as water supply, agricultural needs, etc. (mm/min); q_l: groundwater related loss (mm/min); Q_0: the initial river discharge just before the rain starts (mm/min) ; k_1, k_2, k_3, p_1, p_2, z, α,: model parameters.

2.2 Performance evaluation

The hydrographs generated by the USF model were assessed using three performance evaluation criteria as follows:
1. RMSE
2. Percentage error in peak discharge (PEP) = [1 - (computed peak discharge/base peak discharge)]*100
3. Percentage error in volume discharge (PEV) = [1 - (computed volume of discharge/base volume of discharge)]*100

3. RESULTS AND DISCUSSION

Based on the previous studies and the researches, the seven parameters of USF model was fixed as follows: k_1=40, k_2=1000, k_3=0.02, p_1=0.4, p_2=0.2, z=10, α=0.5. We analyzed each parameter characteristics by changing its value between the possible physical minimum and maximum values by keeping other parameters fixed. **Fig. 1 (a)** and **(b)** show the reproduced hydrographs simulated by the USF model and **Fig. 1 (c)** and **(d)** demonstrate the performance evaluation criteria's of RMSE, PEP, and PEV values for the selected parameter cases of events 1 and 2. **Fig. 1 (a1, a3, a6)** and **(b1, b3, b6)** revealed that there is a decrease in the estimated peak discharge when k_1 and k_3 values increase from their base values whereas the peak discharge increases with the increase in z value and vice versa. **Fig. 1 (a2, a4, a5)** and **(b2, b4, b5)** show that the time to peak discharge changes largely in the reproduced hydrographs of events 1 and 2 whether there is an increase or decrease in k_2, p_1, and p_2 values. **Fig. 1 (a7) and (b7)** show none of the hydrographs of two events were affected by parameter α irrespective of its value changes. Further, **Fig. 1 (c)** and **(d)** show that the RMSE, PEP, and PEV values change substantially with the increase or decrease of each parameter from their base values.

CONCLUSIONS

In this study, we investigated the parameter characteristics of USF model applied in the upper Kanda river basin by varying one parameter value at a time using the performance evaluation criteria of RMSE, PEP, and PEV. It was found that all the

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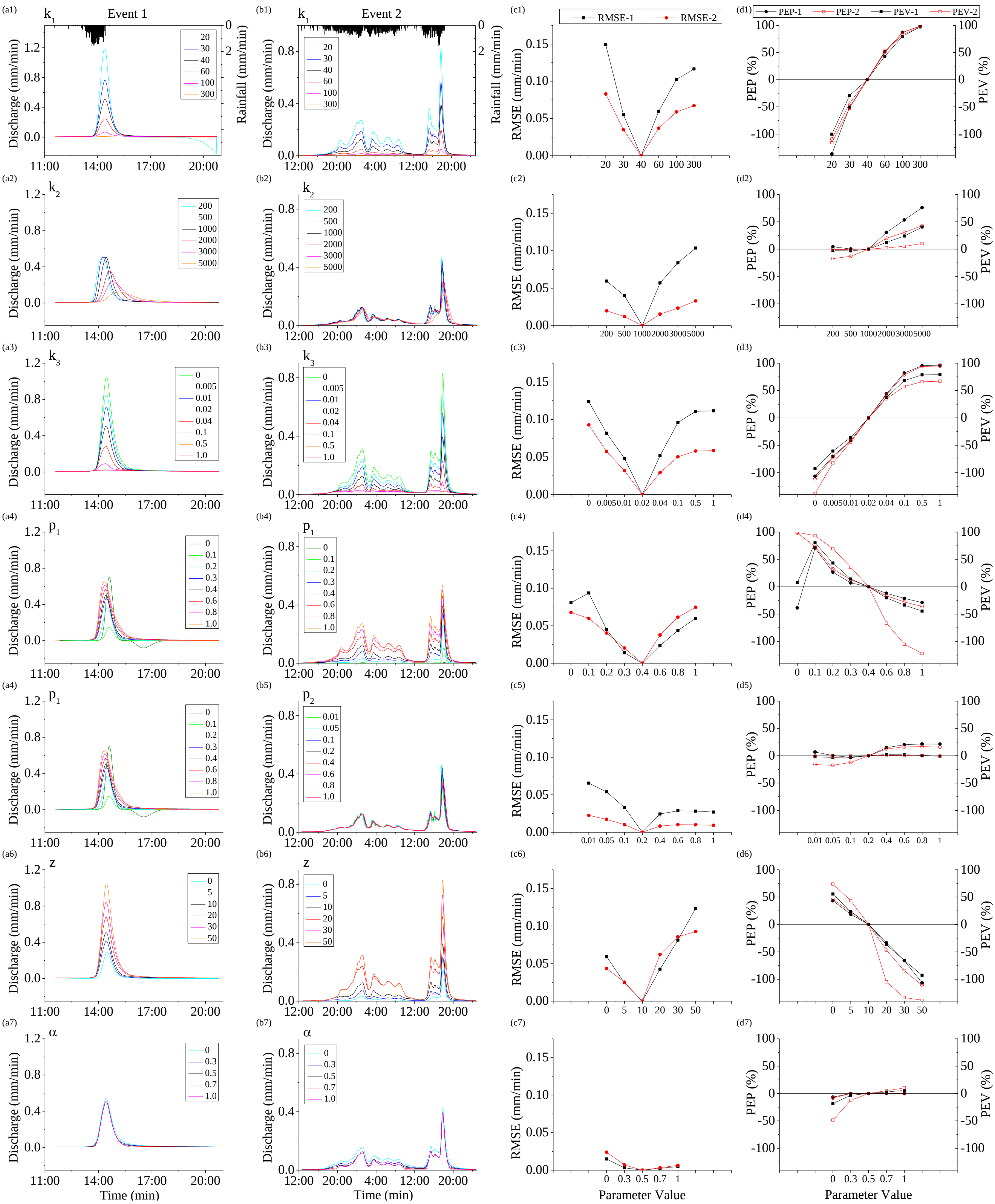

Fig. 1 Reproduced hydrographs and different performance criteria of RMSE, PEP, and PEV generated by USF model for Event 1 and Event 2.

parameters have a high impact on peak discharge, time to peak as well as the overall shape of the reproduced hydrographs except for parameter α. Therefore, we have to pay more attention while calibrating the USF model to improve its accuracy.

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