Paddy Water Storage Dynamics during Flood Period in South Korea

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Abstract: A daily paddy water balance model was developed using four years field experimental data of two locations. From the modeling results, it was possible to simulate the daily ponding depth of paddy by treating paddy levee height and threshold ponding depth indicating irrigation time as ten days average parameters of the model. The storage amount of paddy during flood period showed little deviation to rainfall amount.

Introduction

In South Korea, paddy fields are scattered within a watershed, mainly around stream. Irrigation water controlled by farmers is retained within the paddy during rice cultivation. Meanwhile the rainwater can be stored in a paddy field as pond water or spilled out from the paddy levee. Paddy field areas have gradually decreased by gradual urbanization during the past couple of decades. This certainly influences the stream discharge, but the quantitative representation of affecting streamflow by the reduction of paddy storage effect is not simple because of the process of water balance under the water management of a rice paddy. To identify the paddy storage effect, it is necessary to conceptualize the interaction of a paddy and rainstorm dynamics and develop a paddy water balance model embedding farmer's water management. The purpose of this study is to quantify the amount of paddy storage during flood period modeling daily paddy water balance.

Model Description

In order to model the water balance of a paddy field during rice cultivation, we adopted a modeling approach combining the Freeboard model with the Simulation model of Le Nogc Sen (1977). This model simulates the daily water level and the freeboard (the gap between the levee height and the ponding depth of water) of the paddy. Paddy evapotranspiration (ET) was calculated by FAO modified Penman equation (Doorenbos and Pruitt, 1977) and the crop coefficients proposed by the Ministry of Agriculture & Forestry (MAF, 1986). Paddy levee height and irrigation method are the main control parameters to model water balance of paddy fields. In this study, the intermittent irrigation method that carries out irrigation to paddy when the ponding depth falls below a given threshold ponding depth, is adopted.

Model Test and Discussion

The model was tested at two locations; Suwon and Yeoju paddy experimental plots (100 m length × 30 m width) that have 2 years each (1996-1997 and 2001-2002) in-situ measurement data. The daily ponding depth, irrigation amount, surface drainage through paddy levee, and deep percolation were measured during

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cultivation period. The model was calibrated by controlling paddy levee height and threshold ponding depth as 10 days average parameters. Fig. 1 shows the sample of measured versus predicted daily ponding depth. The 4 years average Nash-Sutcliffe efficiency R^2 (Nash and Sutcliffe, 1970) for the model was 0.76.

The storage ratio (storage/rainfall) linearly decreased as total rainfall amount during the cultivation period increased within the range of observed rainfall (Fig. 2). However, the absolute amount of rainfall stored in paddy showed a small variation ranging from 306.9 mm to 343.6 mm (average storage amount: 333.3 mm) irrespective of total rainfall during the cultivation period. Thus the value of average storage amount 333.3 mm is assumed to be applied to extended rainfall amount, we can deduce that the storage ratio is expected as 100 % under 333.3 mm rainfall, and 33.3 %, 27.8 %, 23.8 % for 1000 mm, 1200 mm, 1400 mm of rainfalls, respectively. These expected values were marked in Fig. 2 as triangle points, and the storage ratio converged to about 20.0 % when the rainfall amount increased.

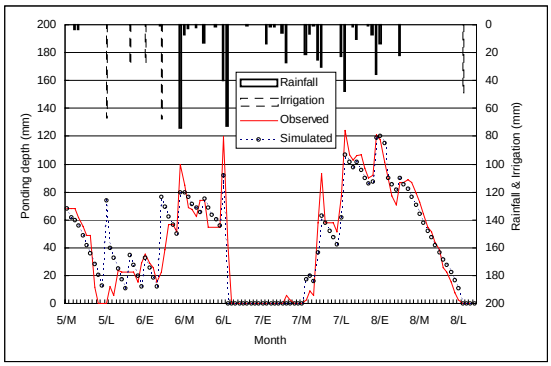

Fig. 1. Comparison of measured and predicted daily ponding depth

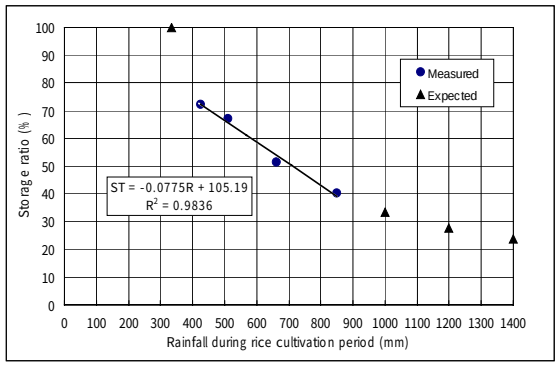

Fig. 2. Relation between rainfall during cultivation period and storage ratio

Conclusion

A daily water balance model was developed with 4 years field experimental data at 2 locations. As a conclusion from the modeling results, it was possible to simulate the daily ponding depth of paddy by treating paddy levee height and threshold ponding depth as 10 days average parameters of the model. The storage ratio (storage/rainfall) linearly decreased as total rainfall amount during the cultivation period increased within the range of observed rainfall

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