POSTER 18

Evaluating the Impacts of Climate Change on Factors of Rice Paddy Water Cycle

N. Y. Park*, S. K. Choi, M. K. Kim, S. O. Hur, and S. C. Hong

Climate and Agroecology Division, National Institute of Agricultural Sciences, RDA, Korea

I. Introduction

Global rise in atmospheric CO_2 concentration and associated climate change expected to affect hydrological cycle such as evapotranspiration, runoff, and irrigation demand. Therefore, research on changes of runoff and agricultural water consumption due to climate change is needed for agricultural water resources planning.

Rice is the predominant grain crop of South Korea with the total paddy fields estimated to be 61 % of the cultivated lands, which occupies 7980 km^2 (Kang *et al*., 2006; Statistics Korea, 2016). Rice cultivation starts in the spring season with transplantation of rice seedling and continues through the fall season as farmers manage wet (semi-flooded) and dry conditions in paddy fields between growth stages of rice. The phenology and water cycle changes in paddy ecosystem due to climate change is very important for agricultural water resources planning in Korea.

This study aims to evaluate changes of water cycle factors in rice paddy with climate change scenario. APEX-Paddy model was selected as evaluation model and input data were collected. The trends of evapotranspiration, runoff and irrigation was evaluated using model output.

II. Materials and Methods

Evapotranspiration and runoff of rice paddy in Icheon province, Korea were evaluated for each divided periods as 1990s (historical, 1981-2010), 2020s (2011-2040), 2050s (2041-2070), and 2080s (2071-2100). APEX-Paddy model which is modified model of APEX (Agricultural Policy/Environmental eXtender) model for paddy ecosystem was used to evaluate evapotranspiration, runoff, Irrigation and yield of rice paddy according to climate change scenario. APEX-Paddy model enable the simulation of both flooded and dry conditions in a rice paddy. The modified subarea module allows for simulating wet condition (i.e. paddy discharge is controlled to retain irrigation water) processes. Under wet condition, the SCS-CN method was replaced by weir discharge function to control surface runoff (Fig. 1).

* Correspondence to : soonkun@korea.kr

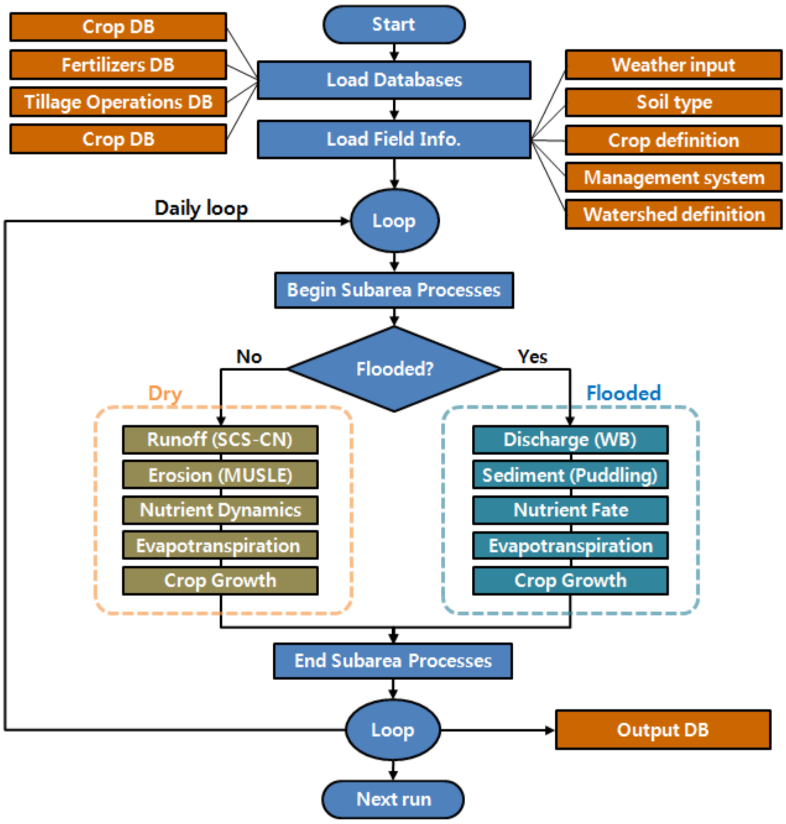

Fig. 1. Paddy algorithm of APEX model.

APEX-Paddy model uses the equations of Monteith(1965) and Stockle *et al.*(1992) for calculating plant transpiration (EP) and Sakaguchi *et al.*(2014) method for actual daily evapotranspiration (EVAP) which consider crop coverage and flood condition. The amount of evaporation from the water surface when a rice paddy is flooded was calculated using the following equations:

$$V_{evap} = \eta\left(1 - \frac{LAI}{LAI_{evap}}\right)E_o \qquad \text{if } LAI > LAI_{evap}, \quad V_{evap} = 0 \tag{1}$$

$$ET = V_{evap} + E_p \tag{2}$$

where, V_{evap} is daily evaporation (mm), ET is daily evapotranspiration (mm), E_o is daily potential evapotranspiration (mm), EP is daily crop transpiration (mm), LAI is leaf area index, and LAI_{evap} is leaf area index during the non-occurrence of evaporation from water surface. η refers to the coefficient of evaporation from the water surface. The default coefficient value was set at 0.6, which is applied to the reservoir module of the Soil and Water Assessment Tool (SWAT) model (Neitsch *et al.*, 2009). LAI_{evap} was set at 4.0, based on the work of Miyazaki *et al.*(2005), which is modified by Sakaguchi *et al.*(2014).

The climate dataset was constructed using climate change scenario data provided by the KMA (Korean Meteorological Administration). The scenario is HadGEM3-RA (Atmospheric Regional climate model of Hadley centre Global Environment Model version 3) by downscaling HadGEM2-AO GCM (General Circulation Model) using the regional climate model (RCM, Regional Climate Model) and statistical downscaling techniques (MK-PRISM: Modified Korean Parameter-elevation regressions and Independent Slopes Model) (Kim *et al.*, 2012; Kim *et al.*, 2013).

Average values of CO_2 concentration for each periods applied to the APEX-Paddy model were as Table 1. The CO_2 data was obtained from input database of FAO-AquaCrop 5.0 model.

Table 1. CO_2 concentration input for APEX-Paddy model

Period / Scenario	1990s (ppm)	2020s (ppm)	2050s (ppm)	2080s (ppm)
RCP 4.5	363.09	424.88	497.47	532.43
RCP 8.5	363.09	435.65	578.07	807.17

III. Results

Fig. 2 represents that the decrease in evapotranspiration of RCP8.5 greater than that of RCP4.5. Though the evaporation increased due to the temperature increases, evapotranspiration was reduced because of the stomatal closure caused by increasing CO_2 concentration. According to Fig. 3, there were no significant differences in runoff for each periods and scenarios. Fig. 4 indicates that, although irrigation is expected to decrease as the reduced evapotranspiration, the irrigation showed a tendency to increase. Increment of irrigation does not show significant difference, the rate of increase in the irrigation was found to be greater RCP8.5 than RCP4.5. These can be explained by changes of precipitation pattern.

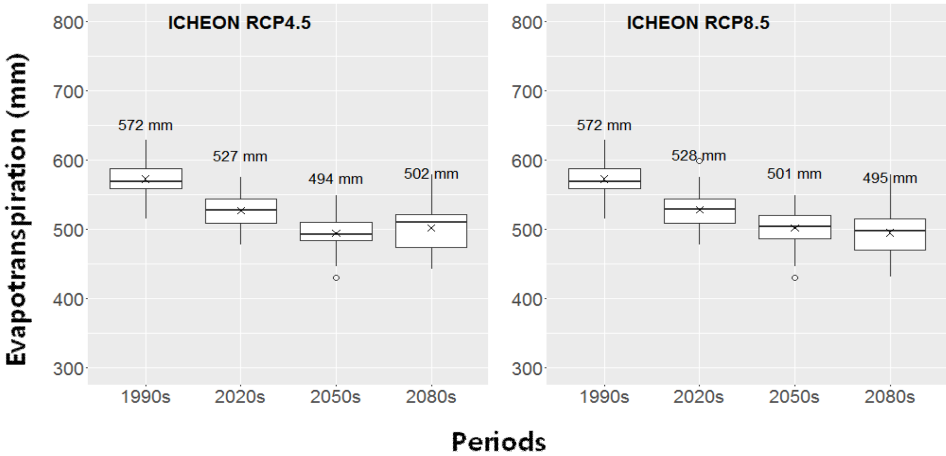

Fig. 2. Trends of evapotranspiration in rice paddy field, Icheon according to RCP4.5 (left) and 8.5 (right) scenarios.

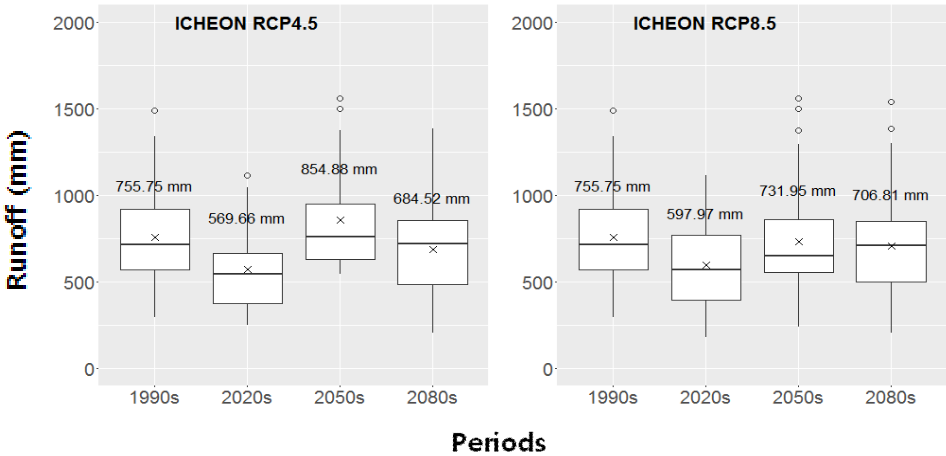

Fig. 3. Trends of runoff in rice paddy field, Icheon according to RCP4.5(left) and 8.5(right) scenarios.

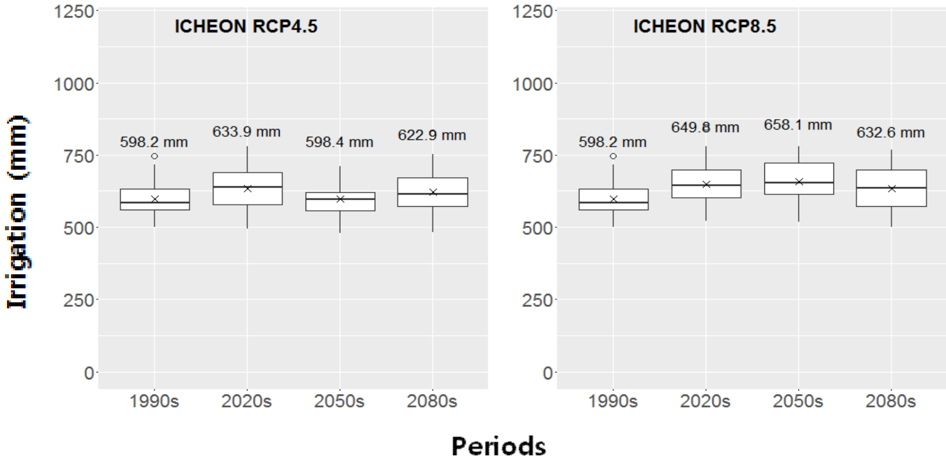

Fig. 4. Trends of Irrigation in rice paddy field, Icheon according to RCP4.5 (left) and 8.5 (right) scenarios.

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