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Development of a coupled model of a distributed hydrological model and a rice growth model for optimizing irrigation schedule

Kumiko Tsujimoto (1), Koki Homma (2), Toshio Koike (1), and Tetsu Ohta (1)
(1) The University of Tokyo, Tokyo, Japan (tsujimoto@hydra.t.u-tokyo.ac.jp), (2) Kyoto University, Kyoto, Japan

A coupled model of a distributed hydrological model and a rice growth model was developed in this study. The distributed hydrological model used in this study is the Water and Energy Budget-based Distributed Hydrological Model (WEB-DHM) developed by Wang et al. (2009). This model includes a modified SiB2 (Simple Biosphere Model, Sellers et al., 1996) and the Geomorphology-Based Hydrological Model (GBHM) and thus it can physically calculate both water and energy fluxes. The rice growth model used in this study is the Simulation Model for Rice-Weather relations (SIMRIW) – rainfed developed by Homma et al. (2009). This is an updated version of the original SIMRIW (Horie et al., 1987) and can calculate rice growth by considering the yield reduction due to water stress.
The purpose of the coupling is the integration of hydrology and crop science to develop a tool to support decision making 1) for determining the necessary agricultural water resources and 2) for allocating limited water resources to various sectors. The efficient water use and optimal water allocation in the agricultural sector are necessary to balance supply and demand of limited water resources. In addition, variations in available soil moisture are the main reasons of variations in rice yield.
In our model, soil moisture and the Leaf Area Index (LAI) are calculated inside SIMRIW-rainfed so that these variables can be simulated dynamically and more precisely based on the rice than the more general calculations is the original WEB-DHM. At the same time by coupling SIMRIW-rainfed with WEB-DHM, lateral flow of soil water, increases in soil moisture and reduction of river discharge due to the irrigation, and its effects on the rice growth can be calculated. Agricultural information such as planting date, rice cultivar, fertilization amount are given in a fully distributed manner.
The coupled model was validated using LAI and soil moisture in a small basin in western Cambodia (Sangker River Basin). This basin is mostly rainfed paddy so that irrigation scheme was firstly switched off. Several simulations with varying irrigation scheme were performed to determine the optimal irrigation schedule in this basin.