Water and mass balance analysis for hydrological model development in paddy fields

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ABSTRACT

There are demands for water environmental analysis of discharge processes in paddy fields, however, it is not fully understood in nutrients discharge process for watershed modeling. As hydrological processes both surface and ground water and agricultural water managements are so complex in paddy fields, the development of lowland paddy fields watershed model is more difficult than upland watershed model.

In this research, the improvement of SWAT (Soil and Water Assessment Tool) model for a paddy watershed was conducted. First, modification of surface inundated process was developed in improved pot hole option. Those modification was evaluated by monitoring data. Second, the monitoring data in river and drainage channel in lowland paddy fields from 2012 to 2014 were analyzed to understand discharge characteristics. As a case study, Imbanuma basin, Japan, was chosen as typical land and water use in Asian countries. In this basin, lowland paddy fields are irrigated from river water using small pumps that were located in distribution within the watershed. Daily hydrological fluctuation was too complex to estimate. Then, to understand surface and ground water discharge characteristics in irrigation (Apr-Aug) and non-irrigation (Sep-Mar) period, the water and material balance analysis was conducted. The analysis was composed two parts, watershed and river channel blocks.

As results of model simulation, output was satisfactory in NSE, but uncertainty was large. It would be coming from discharge process in return water. The river water and ground water in paddy fields were exchanged each other in 5.7% and 10.8% to river discharge in irrigation and non-irrigation periods, respectively. Through this exchange, nutrient loads were exchanged between river and paddy fields components. It suggested that discharge from paddy fields was not only responded to rainfall but dynamically related with river water table.

In general, hydrological models is assumed that a discharge process is one way from watershed to river. However, in lowland paddy fields, discharge process is dynamically changed. This function of paddy fields showed that flood was mitigated and temporally held as storage in ground water. Then, it showed that water quality was changed in mitigated function in the water exchange process in lowland paddy fields. In future, it was expected that hydrological models for lowland paddy fields would be developed with this mitigation function.

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