Applying SWAT model to estimate effects to mitigate nutrient losses by improved fertilization in Ibaraki, Japan

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The aim of this study is to apply SWAT model to estimate water, sediment(SS), and nutrient movements of the rice paddy watershed (Sakura River basin, Ibaraki, Japan). The river is one of tributaries of Lake Kasumigaura, which is the second largest lake in Japan and whose water is used for domestic, agricultural and industrial purposes in spite of insufficient water purity. The area of the basin is 335 km^2, of which 29% is used as paddy fields and 20% as upland fields. The paddy fields are irrigated by Kasumigaura Canal. For modelling the basin characteristics, digital data including DEM (10m mesh by MLIT, Japan), land use data (100m mesh by MLIT), and soil map data (100m mesh by NIAES) were used. Besides, meteorological data at 3 stations, Soil-Profile Physical Properties Data set (“Solphy-J” by NIAES), irrigation water supplying data (Kasumigaura Canal O & M Office), and a general crop calendar were also used. The amount of domestic discharge was determined in proportion to the urban area of each sub-basin on the hypothesis that people live evenly in urban areas. The domestic discharge was assumed to have been added directly into the stream, because the saturation level of sewage was low in the upper area of the observation station located in the lower reach of the river in the watershed. Water, sediment (SS), Org-N, NO_3-N, Org-P, and Min-P were added constantly into the stream from every sub-basin in proportion to the calculated population of the sub-basin. The surface runoff was estimated with “Daily Rain/CN/Daily Route” method. For calibration and validation of the model, daily stream water flow data, and SS, TN, TP, NO_3-N, and Ortho-P data was measured a few times a month at the station. For model run, 3 years (2000-2002) was assigned to the warm-up, 3 years (2003-2005) to the calibration, and the following 3 years (2006-2008) to the validation. By adjusting several parameters, relatively good estimations were attained for daily stream water flow and daily SS (R^2>0.6, NSE (Nash-Sutcliffe efficiency coefficient)>0.6). Certain levels of correlation were gained for nutrients (Organic-N, Organic P, NO_3-N) with R^2 from 0.3 to 0.8 and NSE from 0.1 to 0.4. By introducing improved fertilization; smaller and more frequent fertilization, NO_3 discharge decreased by 20 %.

Keywords: SWAT model, nutrient discharge, improved fertilization

