Improved PCPF-1@SWAT model for watershed simulation of pesticide fate and transport

PCPF-1@SWAT モデルの改良と農薬動態の流域スケールシミュレーション

Julien Boulange[1], Hirozumi Watanabe[1], Minghua Zhang[2], Yuzhou Luo[2], Jeff Arnold[3]

ブランジェ ジュリアン[1]、渡邊 裕純[1]、ザン・ミンフア[2]、ルオ・ユーゾー[2]、アーノルド・ジェフ[3]

Introduction:

Modeling has now become an integral part of pesticide registration, management, and mitigation processes. To fulfill these various purposes, a great number of models were developed. Reviewing the available models for watershed pesticide fate and transport simulations, it was identified that models which were focusing on pesticide applied to upland fields did not considered or over-simplified pesticide fate and transport processes involved in paddy fields. On the other hand, models targeting pesticide applied to paddy fields ignored or over-simplified pesticide processes involved in other types of land use. As a result, a need for a model that could accurately simulate simultaneously pesticide fate and transport in upland and paddy fields was identified and resulted in the creation of the PCPF-1@SWAT model. The model was initially validated on the Sakura River watershed, Ibaraki, Japan where it accurately predicted the fate and transport of mefenacet. The model was also applied to the Colusa Drain Basin watershed, California, US where limitations of the model regarding to seepage and water transfer processes were emphasis.

Objective:

The main objective of this research is to improve the PCPF-1@SWAT model. Specifically, a seepage algorithm is implemented in the code. The improve PCPF-1@SWAT model is then use with a refined rice scenario on the Sakura River watershed and the Colusa Drain Basin watershed.

Method:

The PCPF-1@SWAT model was created by integrating the PCPF-1 model into the SWAT model. Briefly, the PCPF-1@SWAT model deals with the hydrology and pesticide fate and transport simulation in paddy fields whereas the SWAT model mainly simulates hydrology and pesticide fate and transport in other types of land use. The model conceptual implementation is illustrated in Fig. 1. The consideration of the seepage process in the model triggered the revision of the rice scenario of the two watersheds.

所属：[1] 東京農工大学（Tokyo Univ. of Ag.& Tech.），[2] カリフォルニア大学デービス校（Univ. of California, Davis），[3] 米国農務省（USDA/ARS） **キーワード：**物質循環モデル、水田、農薬

Results and Discussion:

The revision of the PCPF-1@SWAT model together with the resulting modifications of the rice scenarios conducted to more realistic simulations of the fate and transport of pesticide applied to rice fields. Indeed, seepage is associated with pesticide discharge and is not altered by the use of water holding period. Consequently, pesticide is susceptible to be loss with seepage water even after the initial application when water holding periods are used. The pesticide peak intensity can also be easily adjusted by calibrating the daily seepage rate.

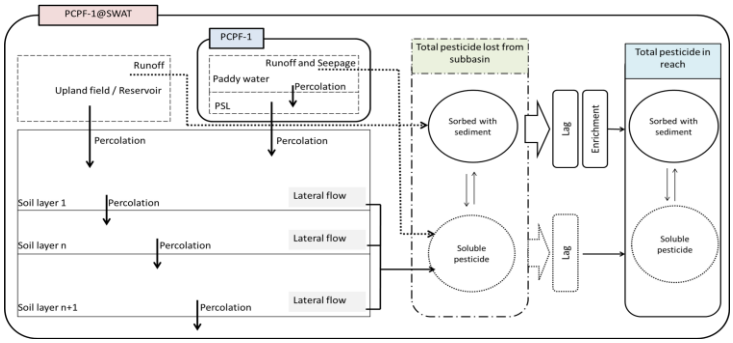

Fig. 1: Conceptual implementation of the PCPF-1 model into the SWAT model

The model accurately simulated the hydrology and molinate fate and transport in the Sakura River watershed with RMSE=0.57, R^2=0.81, and E_{NS}=0.55. On the other hand, the model still has difficulties simulating areas where hydrology is not naturally driven. Consequently, the pesticide fate and transport simulations in the Colusa Drain Basin watershed were more contrasted. In addition, if the simulations of molinate and thiobencarb fate and transport in the Colusa Drain were in agreement with the observed concentration in Highway 20 (middle of the watershed), they were not as accurate at knights landing location (outlet of the watershed). These results may be due to the pesticide dilution in the drain and the bias regarding pesticide application amount and timing.

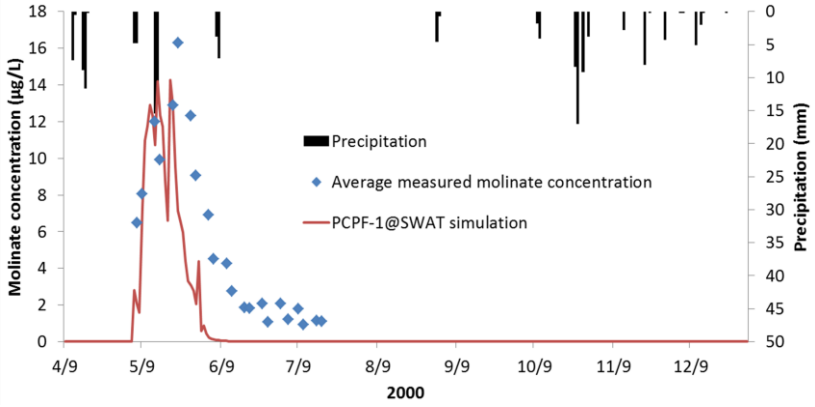

Fig. 2: Simulation of molinate in the Colusa Drain basin watershed

Conclusions:

The PCPF-1@SWAT model was improved by the consideration of seepage in rice paddy fields. Although the predicted pesticide concentration in the Sakura River and the Colusa Drain Basin watershed did not greatly changed, the model is now able to simulate realistic water holding period range. Moreover the integration of the seepage process simplifies the calibration of the paddy fields conditions and gives the model more flexibility.