棚田地域における水文モデル SWAT の適用
－インドネシア国オノギリケドゥアン流域の事例研究－
Hydrological model SWAT application to terraced paddy field
- Case study of Keduang watershed, Wonogiri, Indonesia-

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1. Introduction

Study on the impact of global phenomena such as climate change, land cover change, and other phenomena require vast amount of data and usually involve complex system analysis. Modelling approach make the process of such analysis simpler and shorten the analysis time. Soil and Water Assessment Tool (SWAT) is a physically based, time continuous simulation model that operates on a daily time step at catchment scale. It is designed to evaluate management practices on water quality and sediment production in large watersheds with varying of soils and land use over long periods of time.

Some soil conservation method, include terracing, has been accommodated inside SWAT using empirical approach that is adjusting some parameter closely related. However, physical condition of terrace influence site's hydrological condition more than empirical approach can describe. In addition to that, SWAT has other shortcomings on simulating certain hydrological condition including paddy field hydrology. As terraced paddy field has substantial role on rice production, development of model simulation will contribute greatly on the study of rice production dynamics. The purpose of this research is to study the method on accommodating terraced paddy hydrology inside SWAT.

2 Study area and methods

2.1 Study area

Keduang river watershed (Fig.1) is located in Wonogiri Regency, Central Java, Indonesia. This watershed is a sub-watershed of Bengawan Solo river watershed which is the longest river in Java. Keduang river watershed has average temperature of 26 ° C annually, relative humidity around 70-90%, and annual rainfall between 1800-2900 mm. Terraced paddy field (rainfed and irrigated) dominates agricultural

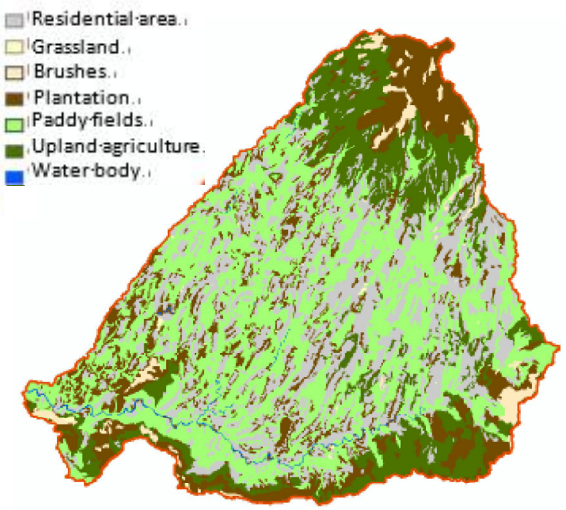

Fig.1 Keduang watershed land

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area in this watershed which comprise 36% from the total land use.

2.2 Methods

First consideration on applying terrace in SWAT was the adjustment of curve number (CN) value and USLE P factor of each HRU containing terraced fields. Consideration of ponded condition was applied by setting pothole in each HRU containing paddy field and adjustment of curve number value was conducted by considering terrace condition of HRU. Through operation process (.ops file) terrace can be applied in certain HRUs. Parameter such TERR_P (USLE practice factor), TERR_CN (adjusted curve number of terrace), and TERR_SLP (terrace slope length) need to be adjusted depend on each HRU characteristic. Second consideration is adapting terrace algorithm developed by Shao, et al (2013).

3. Result and discussion

Based on the previous research of surface water monitoring in terraced paddy block area, it was indicated that there was large amount of water irrigated to terraced paddy loss through percolation/seepage while water use by crops only amount to 19 – 28%. Depend on the objective of water management, controlling irrigation amount can influence the amount of water loss in terraced paddy area. As water lost from upstream area may become irrigation input for downstream area, efficiency on a wider scale water management may be higher due to recycle use system of water. In addition, integrating management of a small scale water management such as paddy fields or blocks into larger scale such as watershed and vice versa can increase the effectivity of water utilization as well as a good step to adapt with the dynamic change of environment.

In this research, SWAT is used to analyze the approach of evaluating watershed containing terraced paddy field in a simulation model. Terraces is applied by adjusting curve number (CN) and universal soil loss equation (USLE) P factor in HRU containing terraced paddy fields. The other approach is by applying terrace operation and pothole fraction in designated HRU. SWAT simulation model didn't show satisfying result yet (Table 1) since the empirical approach for simulating terrace effect cannot represent the actual condition of terraced paddy fields. Furthermore, crop growth simulation inside SWAT couldn't show a good performance in simulating rice growth yet. Further improvement of simulation will be conducted to find the optimal approach on simulating terraced paddy.

Table 1 SWAT model evaluation statistic

	Adjusted CN and USLE_P +pothole	**Adjusted CN and USLE_P + terrace operation**	**Adjusted CN and USLE_P + terrace operation + pothole**
NSE (>0.5)	0.53	0.43	0.35
R^2 (>50%)	0.57	0.54	0.48
RSR (<0.7)	0.68	0.75	0.80
PBIAS (-25%-25%)	42	45.8	44.1