インドネシア国オノギリ市クドゥアン流域における棚田の水収支解析

Water balance analysis in the terraced paddy field of Keduang watershed, Wonogiri, Indonesia

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I. Introduction

Terracing is believed to be one of the effective method on conserving land in the mountainous area. It also has function on harvesting the water and store it in the field. Because of its potential, terraces development has been contributing on the extension of agricultural land. Especially in the area which has large mountainous area such as Indonesia. As important as lowland paddy field, terraced paddy field has become an integral part of rice production in Indonesia.

A well-managed water application in upstream of terraced paddy fields means that it can convey better water availability onto downstream area. Especially in dry season, farmers need to be more careful on the application of water so that limited water resources can be distributed optimally.

Different from lowland paddy fields, terraces has a unique water movement that comprise of interchanging surface water and groundwater movement because of its contoured relief. This dynamic system makes water management in terraced area more complex than lowland one. To study on the general movement in terraced paddy field, modelling of water movement and analysis on the water balance could be one alternative. For that purpose, monitoring of surface water during cultivation period has been conducted in a small catchment area of terraced paddy field from September last year.

SWAT (Soil and Water Assessment Tool) is a physically based model simulating hydrology related processes in a river basin or watershed scale. It was developed to predict the impact of land management on the environment. SWAT uses water balance as a driving force to simulate all processes happening in watershed. Terraces effect has been integrated in SWAT to predict runoff and sedimentation affected by terracing (Shao, et al. 2012).

II. Study area and methods

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 Indonesia. Keduang river watershed located between 7º32¹- 8º 15¹ S dan 110º 4¹- 111º18¹ E with average

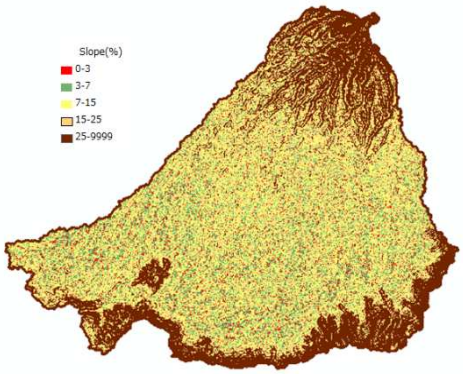

Fig.1 Keduang watershed slope distribution

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temperature of 26 ° C annually, relative humidity around 70-90%, and annual rainfall between 1800-2900 mm. Land use in the watershed comprised of 36% of rice cultivation area. Rice cultivation in this area mostly conducted in terraced paddy fields. With more than 60% of the area have slope more than 7% this area has been contributing most of its sediment to Gadjah Mungkur dam.

An area of 8.58 ha was selected as an observed area. It is said that geological composition of terraced affect the flow pattern of water. Therefore a small catchment with relatively homogenous composition of soil can minimize the complexity of flow pattern. Rice farmers in this area has been cultivating rice intensively every year, especially in the upper stream area rice has been cultivated three times a year

2. Methods

Inflow amount and outflow amount were recorded using data logger installed in irrigation and drainage lining. Historical data of climate and hydrology condition in this watershed helps to simulate water balance in large scale catchment using ArcSWAT model to provide the simulation result of hydrological condition of sub basin where the observed area belongs. Governing equation of water balance will be derived and adjusted with the terraced characteristic to analyse water balance in the observed area.

III. Ongoing result and discussion

In dry season usually farmer gets higher yield of rice production compare to in the rainy season. Since rainfall amount is smaller and events of rainy day is fewer, farmers have greater chance managing their lands. During monitoring period, no rainfall observed then, probably, groundwater level is assumed as low. These conditions can simplify analysis of water balance.

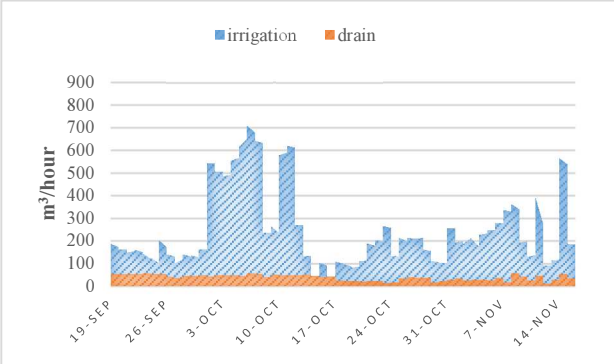
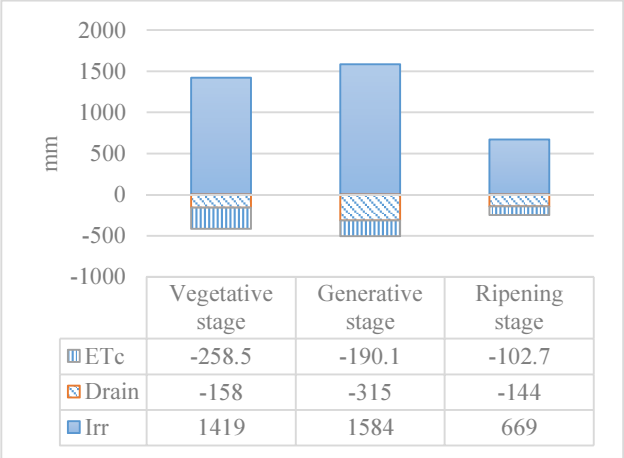


Fig.2 monitoring result of inflow and outflow in the observed area

From the monitoring result on dry season cultivation period (Fig.2), it can be seen that while the inflow fluctuate greatly the outflow was stable. The remaining water outflow disappear from evapotranspiration process and infiltrate into the soil. As remaining outflow is still high that was shown in Fig.3, this outflow most likely infiltrate into the soil, then flow down as lateral flow or deep percolate into groundwater.



	Vegetative stage	Generative stage	Ripening stage
ETc	-258.5	-190.1	-102.7
Drain	-158	-315	-144
Irr	1419	1584	669

Fig.3 Measured and calculated value of water balance (irrigation, drainage, and evapotranspiration)

Water movement will be modelled and studied further by considering soil characteristic and terraces structure. By knowing the characteristic of water movement in this area, important factors affecting hydrological condition could be analysed and referred as suggestion on how to manage water application better in the terraced paddy field.