水管理・水配分モデルにおける水田稲作と畑作の違いについて
Difference of Paddy Rice from Non-Paddy Crops in Water Management and Distribution Model

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1. Objective

Water issues have gathered a lot of attention since the last WWF3 in which heated discussions took place concerning such issues. Water issues have close relationships with food production, health and environmental problems. Food production is owing to distribution and management of water. It is, therefore, necessary to clarify how water issues impact crop production. There are some world simulation models which can deal with the relation between crop production and water issues. The IMPACT-WATER model, which was developed in 1995, is one of such models. IWMI (International Water Management Institute) and IFPRI (International Food Policy Research Institute) are currently developing a new model, WATER-Sim, using the main features from the IMPACT-WATER model. The new features of the WATER-Sim model compared to IMPACT-WATER are introduction of ROEM (Regional Open Economy Model) and increased sub-basin compartments. Both IMPACT-WATER and WATER-Sim models have been developed mainly for non-paddy areas, so their validities to the areas dominated by rice paddy are highly questionable and needs to be reexamined.

In this report, the author tried to make the differences clear between the areas predominantly covered by rice paddy and by non-rice paddy. Here, the water related issues in the Mekong river basin which is dominated by rice paddy cultivation were considered. If the water issues in this region can be clarified, it is possible to incorporate them into the new WATER-Sim model. This task has been carried out in collaboration with IWMI (based on Sri Lanka) from year 2003.

2. Difference rice paddy from non-paddy (upland) in terms of water issues

1) Crop production: In the IMPACT-WATER model, crop yields are calculated with potential optimum yield, evapotranspiration and reduction factors (*ky*). The coefficient *ky* for rice has been derived from the FAO papers, but its validity for rice is doubtful since the reduction coefficient is generally difficult to be determined.

2) Area response function: The areas cultivated depend only on the price of rice in the market in the IMPACT-WATER model. Rice, however, is a staple food in many Asian countries and should have low elasticity on production against the price. The areas cultivated for rice and rice production depend not only on food prices but also on many other factors such as water management. And since areas which can be cultivated for rice are repeatedly inundated by heavy rainfall, there is little room for introducing other sustainable field crops than rice. The areas cultivated for rice production, therefore, should not be estimated

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by using just the price of rice in the market like many other commercial upland crops.

3) Effective rainfall: The concept of effective rainfall has been incorporated in the IMPACT-WATER and the WATER-Sim model. In these models, effective rainfall is determined by using total precipitation and the factor *k*, which is a correction factor and is dependent on the applying depth. The *k* factors for crops other than rice have been determined by using the FAO and USDA-SCS methods. The validity of the k factor for rice, however, seems to be questionable for the reason that the temporal diversity and fluctuation of amout of precipitation in rice cultivated area is much higher than that in non-paddy cultivated ones. Another correction factor, λ, has also been incorporated into the model for the increased amount of effective rainfall through water harvesting area. However, in the rice cultivated area, this factor should be reconsidered because of large water collecting area behind that.

4) Basin efficiency: Basin efficiency, *BE*, is calculated using effective water consumption to produce crop divided by total irrigation water consumption and it indicates how effectively water is used. Its application to rice production, however, tend to mislead the estimation during dry spells in rainy season. Because infiltration in rice paddy during dry spell can be dramatically reduced through regulatory group water management. Infiltration also recharges groundwater to a certain extent and it is an important water source especially in dry periods. Water performance is calculated by BE (at IMPACT-WATER) and depletion coefficient or effective coefficient for WATER-Sim model. However, the term "effective" should be defined more clearly, otherwise infiltration and return flow are usually regarded as ineffective in the water account.

5) Water allocation: In the IMPACT-WATER model, committed flow to conserve the environment is incorporated and given first priority. The rest of water is allocated to other users, and the model places first priority of water allocation on domestic and industrial water uses and the rest of water is supposedly used for irrigation or agricultural use. However, it is not always the case in Asia. But, it is probably not very practical. And the committed flow also varies in time. All these points should be taken into consideration.

6) Storage use: The stored water in reservoirs not only makes water readily available but also regulates flooding. Actually, water at the reservoir is regulated by the own rule taking into consideration of prevent flood disaster. This idea has not been taken into consideration.

7) Other values: Rice paddy has many multi-functional roles but this has not been taken into consideration in the WATER-sim model. Especially, terrace rice paddy plays great roles in regulating soil erosion and flood inundation. Rice paddy can also help farmers create other sources of income such as duck feeding and aquaculture, etc. These should also be taken into consideration.

3. Conclusion

The points which have been and should be introduced in the future to the new water use and allocation model, WATER-sim, were discussed in this paper. Some of the points need to be included in the model have been suggested to IWMI, which is responsible for WATER-Sim coding, and already incorporated. However, larger change seemed to be difficult because the objective of the WATER-Sim model is targeting global scale mainly upland field. Since almost 50% of water used globally is used for rice production and applicability of the model to the areas dominated by rice paddy is questionable, accountability of the model is unavoidably vulnerable. Perhaps, it is necessary to develop a model which can deal with rice paddy dominated areas better on a global scale.