ESTIMATION OF CROP WATER REQUIREMENT AND IRRIGATION EFFICIENCY USING CLOUD–BASED IRRISAT APPLICATION IN THE LOWER PING RIVER BASIN, THAILAND

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ABSTRACT

Estimation of crop water requirement (ET_c) is certainly essential for canal operators to evaluate the current status of irrigation water use and roles of irrigation in supplying water to meet crop requirements and improving the irrigation efficiency (IE) at the field scale. ET_c can be obtained based upon the reference crop evapotranspiration (ET_o) and crop coefficient (K_c). This study presented the K_c values generated from Cloud–Based IrriSAT application which is a satellite–based supportive tool for irrigation scheduling. The dynamic values of K_c of three irrigation schemes located in the Lower Ping River Basin namely; Tortongdang (TD), Wangbua (WB) and Wangyang–Nongkwan (WY–NK) during 2000–2020, were obtained and monitored using updated satellite imagery data of planting areas over growing seasons during an entire year for ET_c and IE estimation. K_c–IrriSAT were accordingly verified and adjusted with average K_c–RID which were calculated as a function of K_c from field observation for the different types of crops and accumulated area size monitored by GISTDA. The results after the calibration procedure revealed the similar patterns of average K_c generated by IrriSAT corresponding to the average K_c–RID and the high correlations between K_c–IrriSAT adjusted and average K_c–RID for TD, WB, and WY–NK irrigation projects were found. The irrigation efficiency can be principally obtained based upon the Net Irrigation Water Requirement (NIR) and Gross Irrigation Water Requirement (GIR). The results of ET_c were applied and seepage losses and effective rainfall were calculated to find NIR for estimating irrigation efficiency. It could be drawn from the results that the irrigation efficiency of TD, WB, WY–NK irrigation projects are 72.16%, 80.33%, and 56.49%, respectively which are relatively high particularly in TD and WB, indicating that the water supplying to the irrigated area was limited and consistent with estimated values of ET_c.

INTRODUCTION

Thailand's economic development has been mostly driven by the agricultural sector. Enhancing agricultural productivity in large–scale irrigation schemes plays an important role to raise the economic growth of the country. Therefore, water supply facilities and irrigation technologies should be potentially provided to farmers for raising agricultural productivity and modernizing the irrigation systems. Evaluating crop water requirement (ET_c) and irrigation efficiency (IE) in irrigation areas requires the crop coefficient (K_c) as an important parameter. The values of K_c are mainly subject to the crop types and dynamic growth periods of crops. This leads to the difficulty in estimating the certain amount of water to be delivered in irrigated areas. Cloud–IrriSAT application can also predict ET_c by referring to the strong relations between the Normalized Difference Vegetation Index (NDVI) in the cultivated area and Kc [1]. Accordingly, this study aims at tracing the dynamic values of ET_c by using cloud–based IrriSAT application to find crop water requirement and irrigation efficiency of three irrigation schemes in the Lower Ping River Basin including TD, WB, and WY–NK with the service areas of 992, 1,336, and 1,129 km^2, respectively.

METHODOLOGY

Cloud–based IrriSAT application was taken to estimate K_c for three main irrigation schemes; TD, WB, and WY–NK during 2000–2020 by identifying the crop growing area as input data. To evaluate the dynamic values of K_c, the GIS shape files of these three irrigation schemes must be converted into Keyhole Markup Language (KML) files. Various forms of K_c were generated through the cloud–based IrriSAT application. However, K_c(average) was only used to validate with those average values of crop coefficient (average K_c–RID) performed by using observation data from the Royal Irrigation Department (RID) and Geo–Informatics and Space Technology Development Agency (GISTDA) during 2018–2019. Validating process of K_c–IrriSAT values was conducted using least square criterion to visualize the good correlation between K_c–IrriSAT and average K_c–RID and to find the adjusted factors corresponding to the specific growing periods. The reference crop evapotranspiration (ET_o) was computed based upon the FAO Penman–Monteith equation and the yearly crop water requirement (ET_c) was quantified using K_c–IrriSAT. The Net Irrigation Water Requirement (NIR) and Gross Irrigation Water Requirement (GIR) were then provided to estimate the irrigation efficiency of each scheme in the last step. Irrigation efficiency (IE) can be computed as the ratio of the amount of water consumed by crops or "Net Irrigation Water Requirement (NIR)" to the amount of water supplied through irrigation or "Gross Irrigation Water Requirement (GIR)".

RESULTS AND DISCUSSIONS

The results show that the maximum K_c(average)–IrriSAT values are 0.6698, 0.6760, and 0.6841 for TD, WB, and WY–NK irrigation schemes, respectively which are much lower than those received from K_c(average)–RID with 1.3942, 1.3412, and 1.3415, respectively. However, it shows the similar patterns of average K_c generated by IrriSAT corresponding to the average K_c–RID over the growing seasons in a year. In addition, correlations between Kc–IrriSAT and average Kc–RID for TD, WB, and WY–NK irrigation schemes are relatively higher with R^2 of 0.8304, 0.8466, and 0.8314, respectively after the validation process was successfully done. The yearly estimated values of NIR are 406.25, 382.83, 247.00 MCM for TD, WB, and WY–NK irrigation schemes, respectively and the yearly measured values of GIR are 562.54, 476.56, and 437.06 MCM for TD, WB, and WY–NK irrigation schemes as illustrated in Fig 1. This indicates that the amount of irrigation water supplied to these three irrigation schemes are still sufficient to crop water requirements. However, high irrigation efficiency were definitely found in the TD and WB irrigation schemes with IE of 72.16% and 80.33%, respectively reflecting the possibility of experiencing the physical water scarcity in this region. Irrigation efficiency of WY–NK irrigation scheme was 56.49% considering as good in term of irrigation performance.

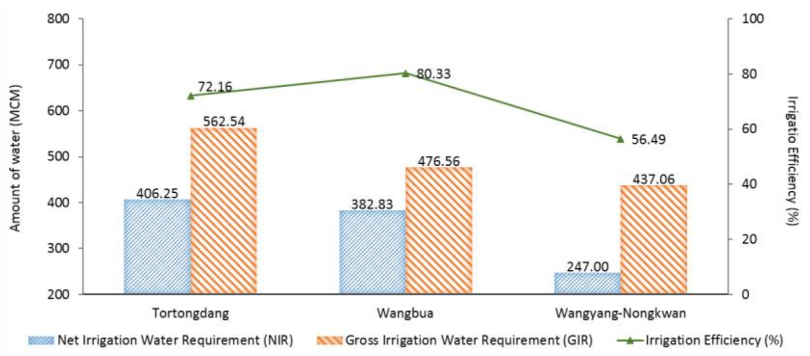

Fig.1 Comparison of yearly NIR and GIR and irrigation efficiency of three irrigation schems

SUMMARY AND ACKNOWLEDGMENTS

This research revealed the estimation of crop water requirement and irrigation efficiency of three irrigation schemes in the Lower Ping River Basin using the cloud–based IrriSAT application. It could be drawn that IrriSAT application can be a useful tool to trace the dynamic values of crop water demand particularly in the small to large irrigation areas. In addition, it is very helpful for the canal operators to specify affordable amount of water delivery and to improve the irrigation efficiency at the field scale.

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