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Evaluation Of Crop Water Requirement For Kyae Bin Et Dam Project

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Abstract

Agricultural development is given priority in Myanmar's socio-economic development as it is seen as essential in its own right and as the basic of the other sectors of the economy. The agricultural sector contributes 43 percent of GDP: 41 percent of export earnings; and employs 63percent of the labour force. More and more food will be necessary for the country's growing population. Small and medium scale irrigation projects have been constructed throughout the country, especially for year-round cultivation of paddy and in conjunction with other crops. Rice is the main food for the people of Myanmar and it is also a principle crop in the agricultural sector. For crops that are climatically suitable, their water requirements must be considered in relation to both water supply and the efficiency of water utilization in crop production (NDSU Extension Service, 1988). Therefore, in the irrigation project, crop water requirement takes place an important role. The objective of this study is to determine the crop water requirement of paddy rice for the area around Kyae Bin Et Dam Irrigation Project. Crop water requirement for paddy rice was determined by using 15-years climatic data from nearest station. Reference crop evapotranspiration (ET_o) was determined by using the FAO Modified Penman method. Paddy rice was planted during Rainy and Dry seasons, the crop coefficients were determined.

Keywords: Crop coefficient, Climatic data, Crop evapotranspiration, Crop water requirement, Penman method, and Reference evapotranspiration

1. Introduction

Myanmar is primarily an agricultural country. The economy of Myanmar is also mainly based on the agricultural produce. Myanmar's paddy fields can be found mostly in the delta and central dry zone areas. About 60 percent of the delta region, including the Ayeyarwady, Bago, and Yangon region of Lower Myanmar, is cultivated with rainfed paddy. Irrigated paddy is cultivated mainly in the Mandalay, Sagaing and Magway regions which are located in the central dry zone of Myanmar. In Myanmar, annual rainfall varies from 500-1200 mm in the central dry zone, 2000-3500 mm in the delta areas, 1200-3800 mm in the hilly regions, and is approximately 5000 mm in the coastal areas. 90% of the annual rainfall is concentrated in the monsoon season, from May to October. The irrigation projects in Myanmar mainly supply water for paddy cultivation. Paddy production has been increased by the dry season paddy cultivation, which has followed rainy season paddy cultivation since 1992. Paddy is currently cultivated under a total area of 6.48 million hectares, comprising 4.86 millions hectares in the rainy season and 1.62 million hectares in the dry season. Supplemental irrigation is supplied for the rainy season paddy cultivation in the central dry zone, where the rainfall is not sufficient for the crop water requirement.

2. Description of study area

Kyae Bin Et project, which is disturbed from Kyae Bin Et Dam, is situated in near Kyae Bin Et village, Kanbalu Township, Shwebo District, Sagaing Division. It is about 5 miles below Shwebo- Myit Kyi Nar high way road. It's main dam was constructed across Kyaebinet creep and has a length of 2.53 km and a height of 23.77m. The reservoir has a gross capacity $20\times10^3 m^3$ with a catchment area of 165.76 km^2. The water spread area is 8.5 km^2 when it is full. It irrigates a target area of 2323 ha. The study area is located at North Latitude 23.20388889 and East longitude 95.51527778 and its altitude is 302 m above mean sea level.

2.1. Climate and Topography of study area

The climate of the study area influenced primarily by the southwest and northeast monsoon and the intertropical convergence zone, and secondarily by the relief of the country and the invading tropical cyclones and disturbances. Three well-marked seasons can be distinguished, the rainy season, cool season and the warm season. Normally, the rainy season lasts from May to October. Between the rainy spells there are occasionally prolonged breaks which may last for several weeks during June-July. After this period rainfall becomes more frequent: the heaviest rain normally falls in the months August to October. The project area lies in the central dry region of Myanmar in the lee of the Rakhine range and receives an average of about 33 inch of rain per year. About 90% of the total rainfall occurs during the period May to October. The general slope is from north to south and from northeast to southwest. Kyae Bin Et Dam project is shown in Figure 1.

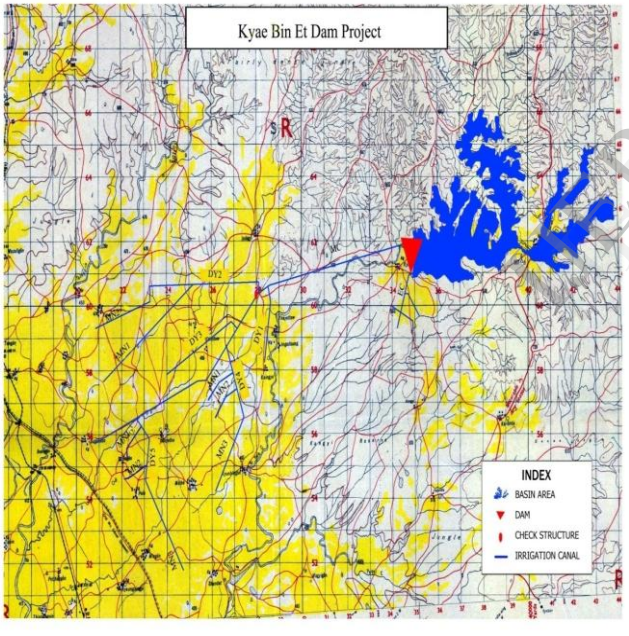

Figure.1.Kyae Bin Et Dam Project

2.2. Rice Area, Cropping Pattern and Schedule

In 1992-93, summer paddies were started (MOAI, 1996) throughout the country in conjunction with irrigation systems. Since then, the cropping season of summer paddies has begun just after the traditional rainy paddy season. Therefore, rice is cultivated in the area twice a year, the rainy paddies from August to December and the summer paddies from March to June. The summer paddies were started in 2003 after construction of the project. About 1500 ha of rainy paddy were cultivated annually in the basin between 2003 to 2007 and during the last 5 years , almost 2500 ha has been cultivated. The total area of irrigated summer paddies was up to about 1100 ha, in the year 2011. The total area of irrigated summer paddies was up to about 1200 ha ,50 % of the project service area, in the year 2011. The sown rice area is seen in Figure.2.

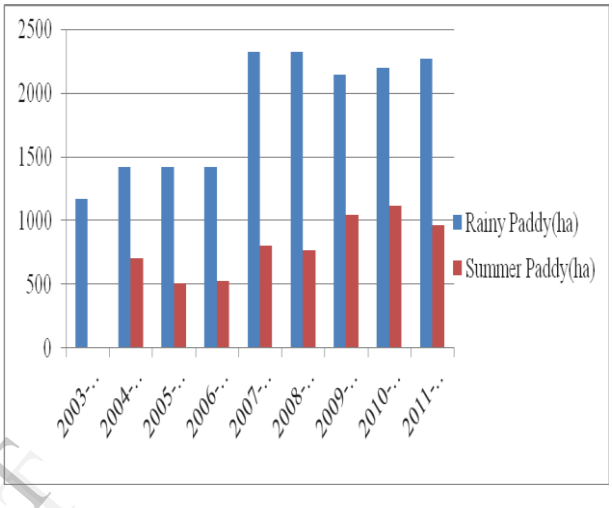

Figure.2.Cultivated paddy area in the Kyae Bin Et Irrigation Project

3. Methodology

3.1. Crop water requirement

Water is important for plant growth and food production. There is competition between municipal, industry users and agriculture for the finite amount of available water, estimating irrigation water requirements accurately is important for water project planning and management (Michael,1999). The primary objective of irrigation is to apply water to maintain crop evapotranspiration (ET_c) when precipitations insufficient. The finite total amount of available water is crucial for the economy, health and welfare of a very large part of the developing world. Hess (2005) defined crop water requirements as the total water needed for evapotranspiration, from planting to harvest for a given crop in a specific climate regime, when adequate soil water is maintained by rainfall and or irrigation so that it does not limit plant growth and crop yield. Normally it is only included crop evapotranspiration for crop water requirement. But total supply water requirement for paddy crop, deep

percolation (vertical), horizontal percolation (from field to drain), water requirement for land preparation and coefficient of efficiencies for losses like conveyance loss are also needed to consider. The amount of water required for a given crop depends on state of development of soil, quantity and type of fertilizer given, quality of water used and the climatic conditions.

The study of crop water requirement is mainly divided into two portions, reference crop evapotranspiration, and crop evapotranspiration. In the reference crop evapotranspiration, factors affecting evapotranspiration were considered. Determination method of evapotranspiration was selected. Required meteorological data of Kanbalu station were collected to estimate reference crop evapotranspiration by using selected determination method for the previous fifteen years (from 1996 to 2010).

3.2. Evapotranspiration Process

Evapotranspiration (ET) is a combination of two processes whereby water is lost from the soil surface by evaporation and by transpiration. Evaporation and transpiration are only varied by meteorological condition and growing stage. Evaotranspiration (ET) is the net water loss caused by evaporation of moisture from the soil surface and transpiration by vegetation. Evapotranspiration from the plants depends upon the meteorological factors, such as temperature, wind, humidity and sunshine hours.

For convenience, reference crop evapotranspiration (ET_o) is first determined and then crop evapotranspiration (ET_c) is calculated. (Doorenbos and Pruitt,1977)Reference evapotranspiration (ET_o) is the evapotranspiration from a short, evenly cut grass of 8 to 15 cm tall , completely shading the ground, never short of water ,disease free, and having uniform fetch. Estimate of ET_o is mostly needed for crop water requirements, sizing of irrigation system components (pipes , valves ,ditches ,canals ,pumps), determining water rights ,hydrological studies ,operation and management of irrigation systems, as well as proper irrigation scheduling. The only factors affecting ET_o are climatic parameters. It does not consider the crop characteristics and soil factors. The crop evapotranspiration, denoted as (ET_c), is the evapotranspiration from disease-free, well-fertilized crops, grown in large fields, under optimum soil water conditions, and achieving full production under the given climatic conditions.

3.3. Methods of Reference Crop Evapotranspiration

Many methods with differing data requirements and levels of sophistication have been developed for computing ET_o. Some of these methods require relative humidity, solar radiation, wind and air temperature data while other need only mean monthly air temperature (Doorenbos and Pruitt, 1977). They are:

(1) Blaney -Criddle method
(2) Ration method
(3) Penman method
(4) Penman- Monteith method
(5) Pan evaporation method

3.4. Penman method

The most commonly used theoretical method is the modified Penman method. In the study, Penman method is expressed. This method based on temperature, humidity, wind, and sunshine duration or radiation. This method would offer the best result with minimum possible error of $\pm$ 10% in summer and up to 20% under low evaporative condition. The form of the equation used in this method is

$$ET_o = c\,[W.R_n + (1-W)\,f(u)\,(e_a - e_d)]$$

Where,

ET_o = reference crop evapotranspiration in mm/day
W = temperature - related weighting factor
R_n = net radiation in equivalent evaporation in mm/day
$f(u)$ = wind - related function
$(e_a - e_d)$ = difference between the saturation vapour pressure at mean air temperature and the mean actual vapour pressure of the air, both in mbar
c = adjustment factor to compensate for the effect of day and night weather condition

The crop evapotranspiration can be obtained by multiplying the reference crop evapotranspiration with crop coefficient.

$$ET_c = ET_o \,.\, K_c \qquad (2)$$

where, ET_c = Crop evapotranspiration
ET_o = Reference crop evapotranspiration
K_c = Crop coefficient

3.5. Crop Coefficient

For paddy rice, K_c values are given in Table (1) for different wind conditions and seasons. No difference is assumed in K_c values between broadcast or sown and transplanted rice since percentage cover during first month after transplantation is little differences in growing season according to variety; therefore the length of mid - season growth period will need adjustment.

Climate	Little wind		Strong wind	
Growth stage (days)	dry	humid	dry	humid
0-60 days after transplant or direct sowing	1.1	1.1	1.1	1.1
Mid-season	1.2	1.05	1.35	1.3
Last 30 days before harvest	1.0	1.0	1.0	1.0

source: FAO, Irrigation Water Management, Training manual No.

4. Results and Discussions

The several varieties of rice with different ages of 135-days, 125-days, 120-days, and 115-days are cultivated in the area, depending on the land and water condition. Nowadays, the farmers, however, have already adopted High Yielding Variety (HYV) rice with a short life for double rice production and requirement of increasing cropping intensity. The traditional varieties become decreasing. HYV rice for rainy paddy with a life span of 135 days is mostly cultivated in this area.

Summer paddies are started after harvesting the rainy paddies, from the beginning of March. Summer paddies are irrigated, broadcasted, and cultivated with HIV rice only, which is mostly a life span of 120 days. The result of reference crop evapotranspiration for summer paddy and rainy paddy are shown in Table (2) and (3).

Table2. Calculation Results of Reference Crop Evapotranspiration (ET_o) for Summer Paddy

Month	March	Apr	May	Jun
ET_o(mm/day)	5.19	6.44	5.40	4.77

Table3. Calculation Results of Reference Crop Evapotranspiration (ET_o) for Rainy Paddy

Month	Aug	Sep	Oct	Nov	Dec
ET_o(mm/day)	4.37	4.5	4.0	3.5	3.0

Factors affecting the value of the crop coefficient (K_c) are mainly depended on the crop characteristics, crop planning or growing season and climatic conditions. Humidity for monsoon paddy is high and summer paddy is low. Wind speed for both monsoon paddy and summer paddy is high. In this study, the values of crop coefficient for summer and rainy paddies are shown in the following Table(4),(5).

Table(4) Crop Factors for Summer Paddy and

Month	Mar	Apr	May	Jun
K_c	1.1	1.1	1.2	1.0

Table(5) Crop Factors for Rainy Paddy

Month	Aug	Sep	Oct	Nov	Dec
K_c	1.1	1.1	1.05	1.03	1.0

Therefore, the values of Crop water requirement for Summer and Rainy paddies , are shownin following Table (6) and (7).

Table(6) Crop evapotranspiration ,ET_c for Summer Paddy

Month	Mar	Apr	May	Jun
ET_c(mm/day)	5.71	7.10	6.48	4.77
ET_c(mm/month)	171.3	212.52	194.4	143.1

Table(7) Crop evapotranspiration ,ET_c for Rainy Paddy

Month	Aug	Sep	Oct	Nov	Dec	
ET_c(mm/day)	4.81	4.95	4.2	3.61	2.99*	
ET_c(mm/month)	144.3	148.5	126.0	108.3	44.85*	

In this study, the results showed that reference crop evapotranspiration (ET_o) and crop evapotranspiration (ET_c) were higher during the dry season than the rainy season. FAO (2005) reported that crops grown in the dry season needs more water than those grown during the rainy season. Same crops grown in different climatic zones may have different water needs. Moreover, summer and rainy paddies need large quantity of water in the growing and developing stages for various physiological functions. The values of summer and rainy paddies in June and December were lower than other months because of stopping of surface water after the maturation stage of rice for 15 days. For improvement of proper water management of the irrigation system, these irrigation projects must be well operated and managed to fully contribute for sustainable agriculture development and other needs. On-farm irrigation development and management including facility development and farmers' participation and establishing water user groups can contribute effective water use and improvement of proper water management system.

5. Conclusion

By using the crop water requirement, the crops are irrigated with the adequate and accurate amount of water and crop yields will be increased. Thus, irrigation schedule decreases the ill effect of the inadequate and over irrigation for the crops. Summer and rainy paddies were considered because of rain water is inadequate for both summer and rainy seasons in this project area. The purpose of this study is to adequate irrigation water for greater challenges in future due to climate change and global warming in the irrigation project.

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