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ASSESSMENT OF CROP WATER REQUIREMENTS FOR KYET MAUK TAUNG IRRIGATED AREA

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Abstract

The estimation of crop water requirements is one of the main components used in irrigation planning, design and operation. The total quantity of water required by a crop from the instant of sowing till it comes to harvesting is known as water requirement of crop in a specific climate regime. Therefore, the optimum amount of crop water requirement is very important for sustainable irrigation system. The crop water requirement can be obtained by multiplying reference crop evapotranspiration with crop coefficient. In this study, CROPWAT 8.0 is used for determination of crop water requirement in combination with meteorological data form Nyaung Oo Department of Meteorology and Hydrology. The estimated total irrigation water requirement for 18165 Ac is 5852.75 MG/month.

Keyword: Meteorological data, CROPWAT8.0 model based on the FAO Penman-Monteith equation, Crop coefficient, Effective rainfall, Irrigation water requirement

1. INTRODUCTION

The irrigation water requirement depends on the crop water requirement and the water naturally available to the crops. The crop water requirement is mainly depend on environmental conditions and crop types. Crop water requirements are the total water needed for evapotranspiration, from planting to harvest for a given crop in a specific climate regime. In this study, CROPWAT8.0 model is used for the calculation of reference evapotranspiration, crop water requirements, and crop irrigation requirements and to develop irrigation schedules under various management conditions.

2. LOCATION OF STUDY AREA

The Kyet Mauk Taung Dam is located in the arid zone of central Myanmar, Kyaukpataung Township, Meiktila District of Mandalay Region. It is situated at north latitude 20° 48' 48" and east longitude 95° 14' 59" at a distance of eight miles south of the extinct volcano, Mt. Popa. The storage reservoir has a water spread area of about 1,800 acres and a maximum depth of 97 feet. It is also designed to have a full tank capacity of 73,100 acre feet allowing 3,100 acre feet of dead storage and enough to supply water to an irrigated tract of 18165 acres. The location of study area is shown in figure1.

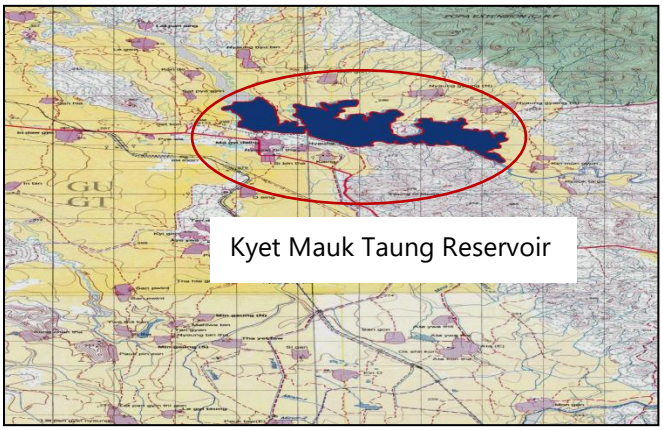

Figure 1 Location of study area

3. MATERIALS AND METHODS

3.1. Meteorological data for study area

For this study area, the meteorological data of 15 years record are collected for the period of 2005-2019. The maximum and minimum temperature, relative humidity,

wind speed, sunshine hours and rainfall are collected from Department of Meteorology and Hydrology. There is no station in Kyaukpadaung. Therefore, meteorological data from Nyaung Oo station are used as Kyaukpadaung station. Nyaung Oo station is situated at north latitude 21˚36' and east longitude 96˚09' and its altitude is 84 m above sea level. For CROPWAT model, seven meteorological data
from 2006 to 2019 are used. They are mean daily maximum temperature in °C, mean daily minimum temperature in °C, mean relative humidity in %, Mean wind speed in km/day, mean sunshine hours per day, mean solar radiation in MJ/m^2/day, monthly rainfall in mm/month. These meteorological data are shown in Figure 2 to 6.

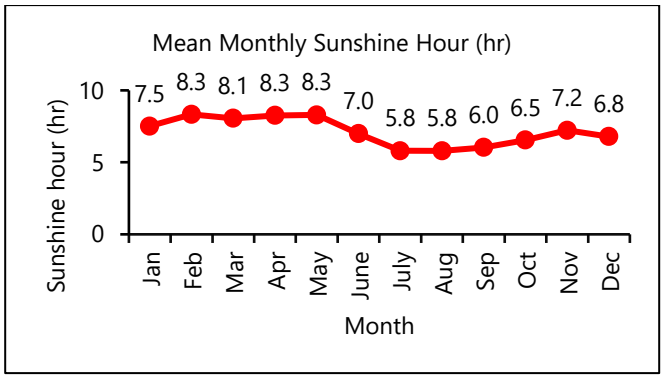

Figure 1 Mean Monthly Sunshine Hour

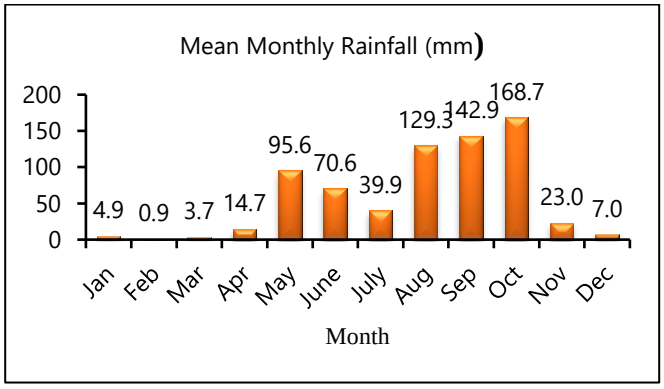

Figure 2 Mean Monthly Rainfall

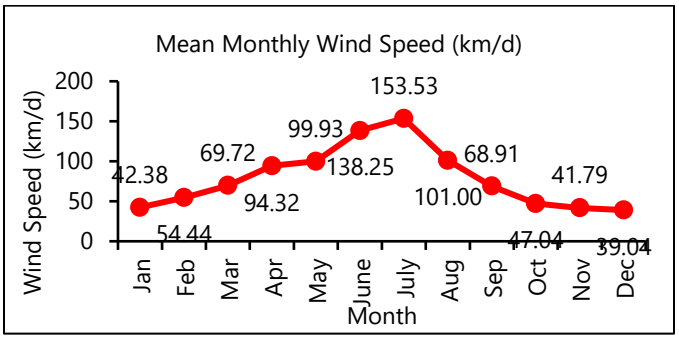

Figure 3 Mean Monthly Wind Speed

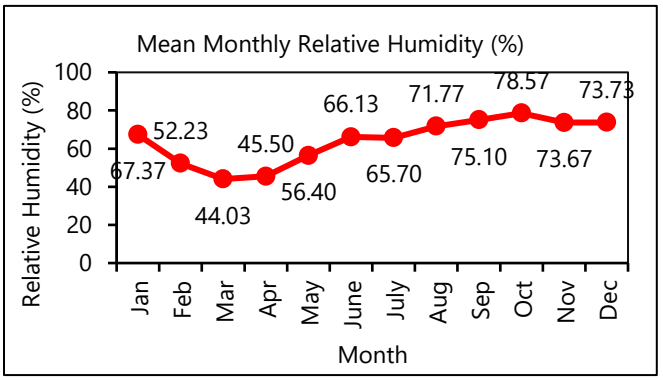

Figure 4 Mean Monthly Relative Humidity

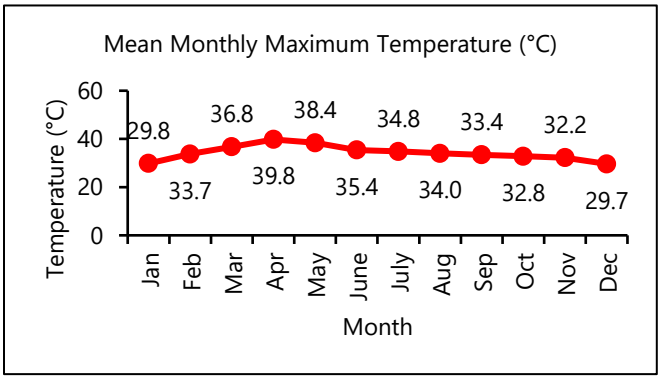

Figure 5 Mean Monthly Maximum Temperature

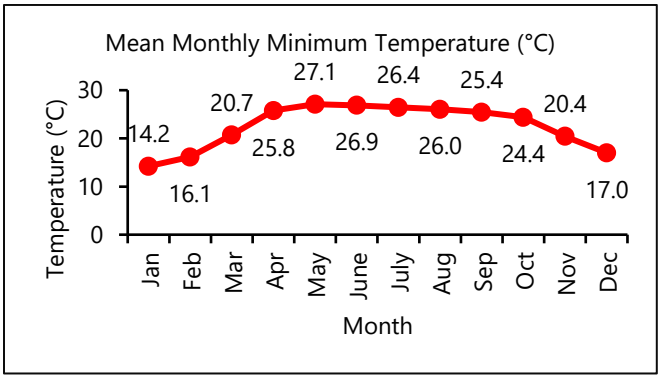

Figure 6 Mean Monthly Minimum Temperature

3.2. The FAO CROPWAT model

CROPWAT is meant as a practical tool to carry out standard calculations for reference evapotranspiration, crop water requirements and crop irrigation requirements and more specifically the design and management of irrigation. Several versions of CROPWAT have been released. CROPWAT 8.0 is an update of earlier method. The model uses monthly climatic data (temperature, relative humidity, wind speed, sunshine hours and rainfall) for calculation of reference evapotranspiration (ET_o). Through the input of crop data (growth stages, K_c factors, root zone depth, critical depletion, yield response and crop height), the programme calculates the crop water requirements and irrigation requirements on a decade (10 days) basis. Procedures for calculation of the crop water requirements and irrigation requirements are based on FAO Irrigation and Drainage Paper No. 56 on Guidelines for computing crop water requirements and No. 33 on Yield response to water. CROPWAT 8.0 software uses the FAO (1992) Penman-Monteith method for calculation of the reference crop evapotranspiration (ET_o).

3.3. Reference evapotranspiration

This parameter was calculated in CROPWAT8.0 Model which uses the FAO Penman-Monteith method (Allen *et al.,* 1998). In this model, most of the equation parameters are directly measured or can be readily calculated from weather data.

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$$

where, ET_0 is reference evapotranspiration ($mmday^{-1}$),R_n is net radiation at the crop surface ($MJ\ m^{-2}\ day^{-1}$),G is soil heat flux density ($MJ\ m^{-2}\ day^{-1}$),T is air temperature at 2m height (°C),u is wind speed at 2 m height (ms^{-1}),e_s is 2 saturation vapour pressure (kPa),e_a is actual vapour pressure (kPa),$e_s - e_a$ is saturation vapour pressure deficit (kPa),Δ is s a slope vapour pressure curve ($kPa\ °C^{-1}$),Y is psychrometric constant ($kPa\ °C^{-1}$).

3.4. Cropping pattern and Crop data

Cropping pattern concerns with are crop type and growing season, planting date and harvesting date. In this study area, the crops and cropping patterns being cultivated in Kyet Mauk Taung irrigated area is collected from Department of Irrigation and Water Utilization Management. The total irrigated area of Kyet Mauk Taung Dam is 18165 acres. The major cultivated crops in study area are monsoon paddy, summer paddy, sesame, groundnut, bean, cottons are the main crops. The cultivated crop patterns for the study are shown in Table 1.The salient details (i.e. crop coefficient, length of growing stages, yield response factor and crop height etc.) of crops considered for the study are as per guide for estimating irrigation water requirement, Ministry of Irrigation, Govt. of India and FAO - Irrigation and Drainage paper, 24 & 56.

Table 1 Cropping Pattern of the Study Area

No	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	→		← Summer paddy →				←	Monsoon paddy		→	←	Bean
2	→		← Summer paddy →				←	Monsoon paddy		→	←	Bean
3	→	←	Cotton			→	←	Monsoon paddy		→	←	Bean
4	→						←	Monsoon paddy		→	←	Bean
5	→						←	Monsoon paddy		→	←	Groundnut
6							←	Monsoon paddy		→		

3.5. Crop Evapotranspiration

For calculation of crop evapotranspiration CROPWAT 8.0 model uses crop coefficient approach and crop water requirements of different crops have been estimated by summing up the crop evapotranspiration in all growth stages.

$ET_{crop} = K_c \times ET_o$

where, ET_c represents crop evapotranspiration, K_c represents crop coefficient and ET_o represents reference evapotranspiration. K_c are considered four growth stages: initial stage, crop development stage, mid-season stage and the late season stage. The K_c values for each crop are considered as per FAO.

3.6. Irrigation water requirement

The irrigation requirement is one of the principal parameters for the planning, design and operation of irrigation and water resource systems. The irrigation requirement is defined as the difference between the crop water requirements and that part of the rainfall which can be used by the plants (effective rainfall). The

irrigation requirements of the study area are computed in CROPWAT 8.0 Model.
Irrigation water requirement= ET_{crop}-P_{eff}

3.7. Effective rainfall

For agricultural production, effective rainfall refers to that portion of rainfall that can effectively be used by plants. Rainfall is highly effective when little or no runoff take place. Small rainfall amounts are not very effective as these small quantities of water evaporate quickly. CROPWAT 8.0 offers the possibility to use several methods to calculate the effective rainfall. In this study, USDA soil conservation method is used to calculate effective rainfall and method is show as follow-
Monthly step:
$P_e = P_{month} \times (125 - 0.2 \times P_{month}) / 125$
for $P_{month} \leq 250$ mm
$P_e = 125 + 0.1 \times P_{month}$
for $P_{month} > 250$ mm

4. RESULTS OF THE STUDY

The simulated values of reference evapotranspiration (ET_o) through CROPWAT 8.0 model using FAO Penman-Monteith equation are shown in Table 2.

Table 2 Results of Reference Evapotranspiration (ET_o)

Month	ET_o(mm/day)
January	2.64
February	3.47
March	4.45
April	5.67
May	5.83
June	5.39
July	5.11
August	4.49
September	4.02
October	3.56
November	3.09
December	2.55

Then, to calculate the crop evapotranspiration and irrigation water requirement, the crop data , the total available moisture is considered as 150 mm/m, the maximum rain infiltration rate is taken as 80 Mm/day, maximum rooting depths is considered as per FAO, initial soil moisture depletion is considered as 40% are added. After the input of the crop data, CROPWAT 8.0 produces crop water requirements and irrigation water requirements using calculated effective rainfall for the given cropping pattern. The results of effective rainfall are shown in Table 3 and the results of crop water requirement and irrigation water requirements are shown in Table 4. Comparison of effective rainfall and irrigation water requirement are shown in Figure 7.

Table 4 Results of Eff rainfall and IN

Month	Rain (mm/month)	Eff rain (mm/month)	IN (mm/month)
January	4.9	4.9	124.8
February	0.9	0.9	32.8
March	3.7	3.7	468.8
April	14.7	14.4	501
May	95.6	81.0	283.5
June	70.6	62.6	54.6
July	39.9	37.4	320
August	129.3	102.6	52.1
September	142.9	110.2	23.3
October	168.7	123.2	0
November	23.0	22.2	46.8
December	7.0	6.9	160.7

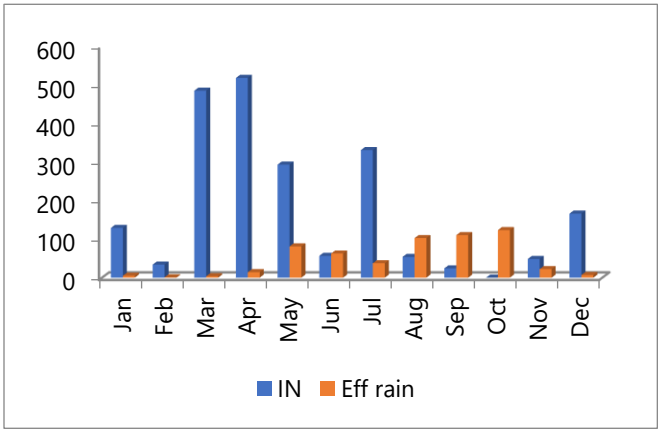

Figure 7 Comparison of effective rainfall and irrigation water requirement

5. DISCUSSION AND CONCLUSION

The exactly value of crop water requirement is very important for planning, design and management of irrigation system. From December to April, there is a little rainfall and irrigation water is needed for growing period. The maximum value of irrigation water

requirement is in April is assessed for developing and efficient water managements system for Kyet Mauk Taung irrigated area to irrigate 18165 Ac.

6. ACKNOWLEDGEMENT

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