COMPARATIVE STUDY OF IRRIGATION SCHEDULING FOR PADDY(SUMMER) - CASE STUDY FOR AAT DISTRIBUTARY NAVSARI OF KLBMC, GUJARAT, INDIA

[1]Dr. Dilip Shete, [2]Mansi Pathak
[1]Profesor, [2] M.Tech Final year student
Civil Engineering Department,
[1] Faculty of Engineering & Technology, Parul University, Vadodara,India

Abstract : This paper estimated the irrigation water requirement of Paddy (summer) in Aat Distributary Navsari of Navsari branch canal KLBMC, by using CROPWAT 9.0 and Water Balance Method. The Meteorological and Rainfall data used for the study were considered from year 2005 to 2017. The effective rainfall obtained by CROPWAT 9.0 and Water Balance Method is 0.4 mm and 9.3 mm respectively. Actual seasonal evapotranspiration by CROPWAT 9.0 and Water Balance Method is 710.1 and 683.3 mm respectively .The net irrigation requirement is 1339.3 mm by using CROPWAT 9.0 and 659.857 mm by using Water Balance Method. Irrigation Scheduling using Water balance method can save water use up to 679.443 mm. The Water Balance Method is more effective and efficient than the CROPWAT 9.0 , only because whereas the earlier method used available soil water at time t over the effective root zone depth and remaining available soil water for irrigation scheduling CROPWAT 9.0 used daily soil water available and readily available water for the same purpose.

***IndexTerms* - CROPWAT 9.0; Water Balance Method; Irrigation Scheduling; Net Irrigation Requirement; Summer Paddy; AAT Distributary;**

I. INTRODUCTION

Irrigation is one of the most important inputs for agricultural production. Limited water resources and increasing water demand for industrial and urban settlements have caused decreases in the quantity and quality of agricultural water use [8].

Accurate estimation of crop water requirements (ETc) of any crop is the critical parameter required for irrigation scheduling and water management [11].

A study was carried out to determine the crop water requirement of few selected crops for the commanded area in the Shimoga Taluka in Karnataka state, India. The crops include cotton & maize for two seasons and sugarcane. By using the 10-year climatic data, Crop Evapotranspiration (ETc) and Reference crop Evapotranspiration

(ET0) for each crop were determined using CROPWAT 8.0. The study shows that for both cotton and maize crops in Rabi season effective rainfall was not sufficient to fulfill the crop water requirement. Hence irrigation requirement is needed to satisfy Crop water requirement [1].

Another study was carried out to determine the crop water requirement of areca nut, banana, coconut, cotton, mango, millet, onion, paddy, pepper, potato, pulses and sugarcane in Tarikere Taluka in Karnataka state, India. Crop water requirement for each crop was determined by using 30-year climatic data in CROPWAT. Reference crop Evapotranspiration (ET0) was determined using the FAO Penman Monteith method. For all the crops considered, three decades: decades I, II, and III and seven crop growth stages: nursery, nursery/land preparation land preparation, initial stage, development stage, mid-season and late season stage were considered [2].

Irrigation Scheduling is the process of supplying the adequate amount of water to crop whenever the soil moisture available to the roots of the crop threatens to be lower than the readily available soil water. Understanding crop water requirements is essential for scheduling and selecting irrigated cropping patterns in specific areas. The calculation of crop water requirements and Evapotranspiration can be used for irrigation schedule planning under varying water supply conditions and reduced yields of various conditions. The purpose of the research was to assess the water requirement of rainfed rice using Cropwat model in the Unter-Iwes Sub district, Sumbawa. The Cropwat 8.0 model with monthly meteorological data input from 2005-2016 in the Sumbawa Regency was used to calculate evapotranspiration, crop water requirements and moisture balance, allowing for adjustment of planting time and evaluation of crop production under dry land conditions. Results showed that the increase in temperature and decreased rainfall can increase the water requirement of rainfed rice plants in the study location [3].

The objective of another study at Dhandhoda, Vadodara, in Gujarat, India is to estimate the crop water requirement and irrigation scheduling using "CROPWAT" for Banana. Various soil data, i.e. type of soil, infiltration rate, and water holding capacity are determined by field experimentation [4]. The model really helps irrigation engineers to analyze the use of crop water of an irrigation system with the different culture and can provide data that are essential for the design of channel. CROPWAT 8.0 can also be used to evaluate farmers' irrigation practices and to estimate crop performance under both rain fed and irrigated conditions [5].

The estimation of irrigation delivery, its schedule and duration is a key element in any irrigation system. An irrigation water delivery-scheduling model has been developed to increase irrigation efficiency for a large-scale rice irrigation project in Malaysia. The study focused on modelling irrigation water delivery schedules during the main season and off-season of the rice-based project. The procedure used a water balance approach in which rainfall was considered as a stochastic variable. Rainfall and evapotranspiration values were used to estimate weekly irrigation water deliveries through the water balance equation. Comparison of the observed and computed irrigation delivery values for the main season and off-season showed that the observed values were higher than the computed values, indicating excess water supply in the field [6].

Research was conducted to study the effect of irrigation scheduling on the water use efficiency and yield of cabbage in Vietnam. Four raised beds were prepared with two replication labeled into various treatment (T1, T2, T3, and T4). Treatment 1 was irrigated every day, Treatment 2 irrigated three times in a week, Treatment 3 irrigated only once in a week and Treatment 4 was under control (No irrigation). Treatment 1 (T1) yielded the highest weight (kg) of cabbage head after harvesting and the lowest water use efficiency as compared to yields of treatment 2 and 3 with treatment 4 yielding the least in weight of cabbage heads [7].

CROPWAT model were compared between plain and hilly region for rice and wheat crop to meet the irrigation demand of crops [9].

A study was undertaken to estimate the crop water requirement (ETc) of ten major crops (Chickpea, Cotton, Green gram, Groundnut, Maize, Mustard, Paddy, Pearl Millet, Soybean, and Wheat) grown in different seasons in Central Gujarat region. The daily reference evapotranspiration (ETO) was estimated by FAO Penman-Monteith method using 20 years (1993 to 2013) mean meteorological data of Anand. The growth stage wise crop coefficients (Kc) modified for daily climatic variation was used to estimate the daily ETc for the selected crops [10].

Understanding crop water needs is essential for irrigation scheduling and efficient water use. Further, with increasing scarcity and growing competition for water, judicious use of water in agricultural sector will be necessary.

The objective of this study is to estimate net irrigation requirement of summer paddy by using the CROPWAT 9.0 software and Water balance Method.

In the present study, Effective Rainfall, Irrigation Scheduling, Irrigation and Net Irrigation Requirement are determined by CROPWAT 9.0 Software and Water Balance Method. Their results are compared to determine most accurate and efficient method.

II. STUDY AREA

The study area isAat Distributary Navsari of Navsari Branch Canal KLBMC Navsari in Navsari District. It is located at 20.95°N 72.93°E. It has an average elevation of 10 m above sea level. The average maximum and minimum temperatures are 40° C and 18° C respectively. The soil of the region is black clayey. In this study ground water table contribution in Irrigation scheduling is not considered as it fluctuates between 6 to 12m. The length of Aat Distributary is 6.100Km. It supplies water to 6 villages' viz. Eroo, Mandir, Hansapore, Bhutsad, Kalthan and Aat. Study area shown in map 1, 2, 3, 4.

Figure 1: Location of Gujarat in India map

Figure 2: Location of Navsari in Gujarat

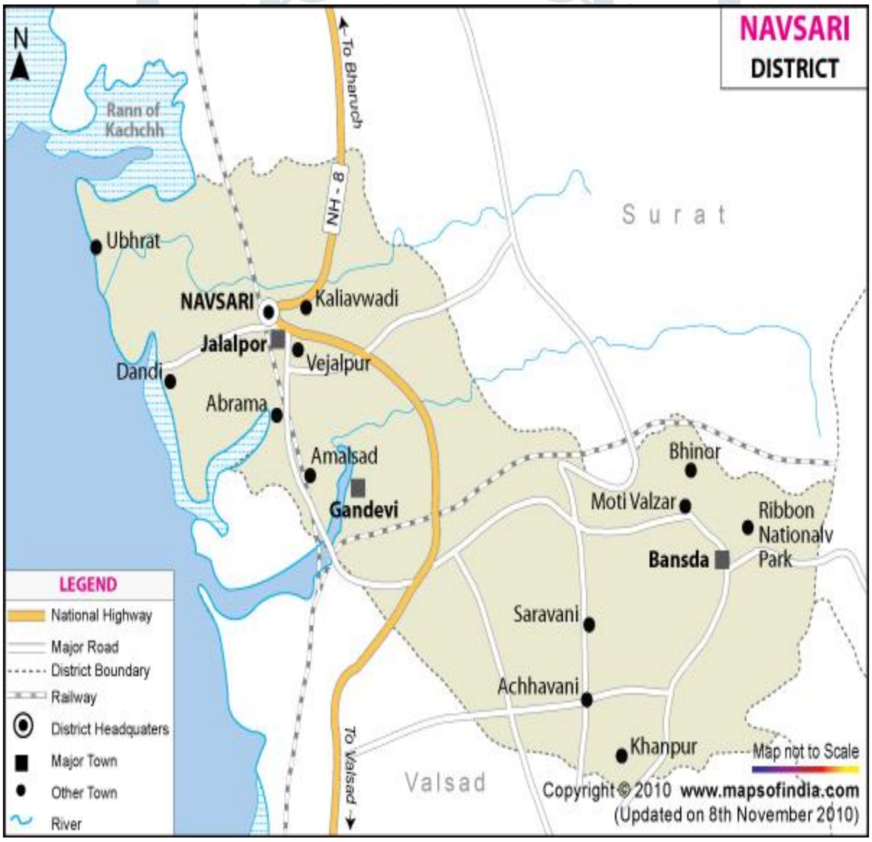

Figure 3: Location of Navsari district

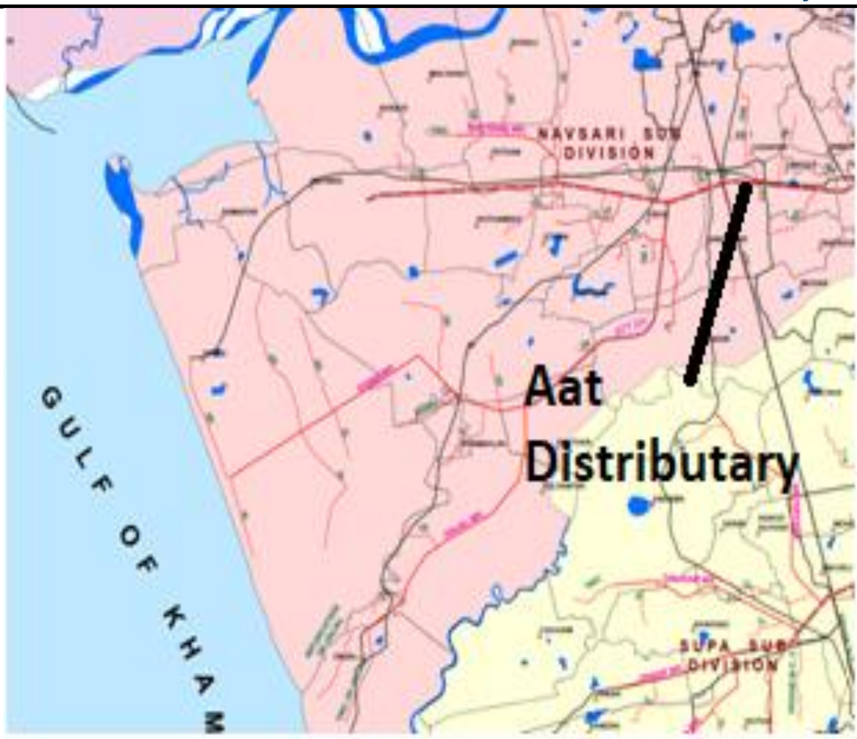

Figure 4: Location of Aat Distributary Navsari

IV. METHODOLOGY

A. CROPWAT 9.0:

Computer model simulation is an emerging trend in the field of water management. CROPWAT is a powerful simulation tool which analyzes complex relationships of on-farm parameters such as the crop, climate and soil, for assisting in irrigation management and planning. CROPWAT is one of the models extensively used in the field of water management throughout the world. CROPWAT facilitates the estimation of the crop evapotranspiration, irrigation scheduling and agricultural water requirements with different cropping patterns for irrigation planning. Reference Crop Evapotranspiration (ETo) values calculated using the Penman-Monteith equation.

B. Water Balance Method:

Irrigation scheduling is carried out after ensuring that the soil water is full on the crop emergence date. Effective root zone depth is achieved at the end of 40% of the cropping season. Therefore daily incremental effective root zone depth is obtained by dividing the effective root zone depth by 40% of the cropping season. Ground water contribution is neglected but effective rainfall is considered. Based on the incremental effective root zone depth, incremental soil water storage and the total available soil water, available soil water at time, over the root depth, D, are calculated. In general, whenever the available soil water at time, over the root zone depth D becomes less than the remaining available soil water, irrigation is to be applied so that soil water is full. While applying water through drip irrigation system in particular irrigation is applied after a few days in the initial stages of the crop growth so that the accumulated crop evapotranspiration over this period results in operation time of 10 minutes. Later on drip irrigation system is operated daily.

$$\text{Available soil water, mm} = Sa*D \quad \ldots \quad (1)$$

$$\text{Remaining available soil water} = (1-p)\ SaD \quad \ldots \quad (2)$$

$$\text{Available soil water at time t over the effective root zone depth } StD = NIR + Pe + Sa*D + S(t-1)D - Eta \quad \ldots \quad (3)$$

$$\text{Net irrigation depth } NI = Sad - (Pe + \Delta Sa*D + S\ (t-1)D - Eta \quad \ldots \quad (4)$$

In which,

Sa = Maximum available soil water holding capacity
D= Effective root zone depth
p = Soil water depletion fraction which depends on the crop and crop evapotranspiration rate.
Pe = Effective rainfall, mm
S = Incremental soil water storage
S (t-1)D = Available soil water at time (t -1) over the root depth
Eta = Actual crop evapotranspiration, mm/day

V. RESULTS AND ANALYSIS

The effective rainfall obtained by CROPWAT 9.0 and Water Balance Method is 0.4 mm and 9.3 mm respectively. Actual seasonal evapotranspiration by CROPWAT 9.0 and Water Balance Method is 710.1 and 683.3 mm respectively. The net irrigation requirement is 1339.3 mm by using CROPWAT 9.0 and 659.857 mm by using Water Balance Method. Irrigation Scheduling using Water balance method can save water use up to 679.443 mm. Irrigation Scheduling by using CROPWAT 9.0 and Water Balance Method are shown in Fig.1 and Fig. 2.

The Water Balance Method is more effective and efficient than the CROPWAT 9.0 for irrigation scheduling, only because whereas the earlier method used available soil water at time t over the effective root zone depth and remaining available soil water for irrigation scheduling CROPWAT 9.0 used daily soil water available and readily available water for the same purpose.

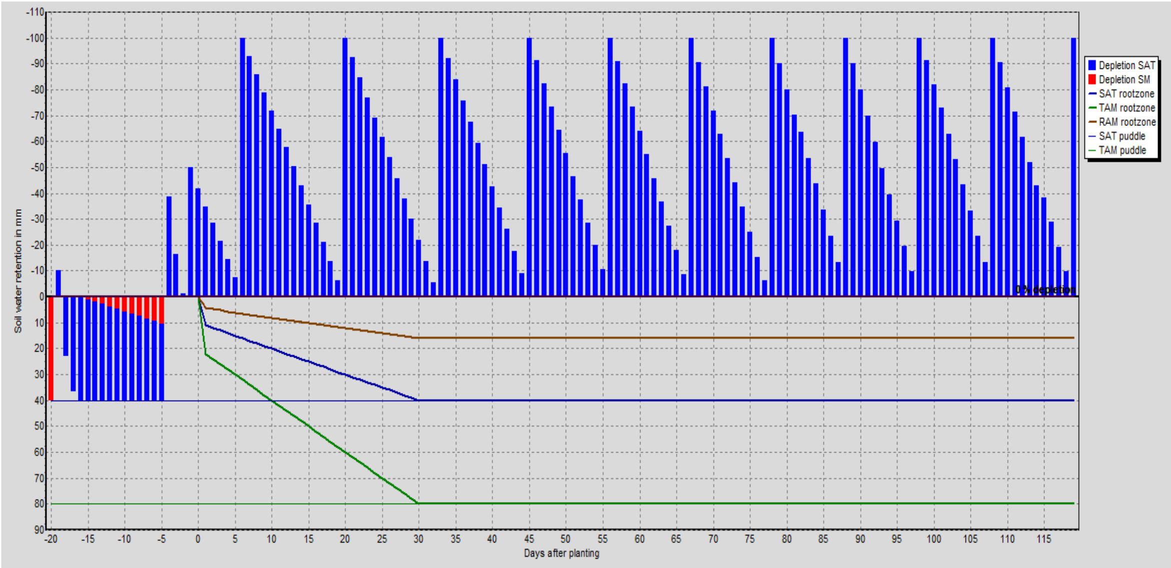

Fig 1irrigation scheduling for summer paddy byCROPWAT 9.0

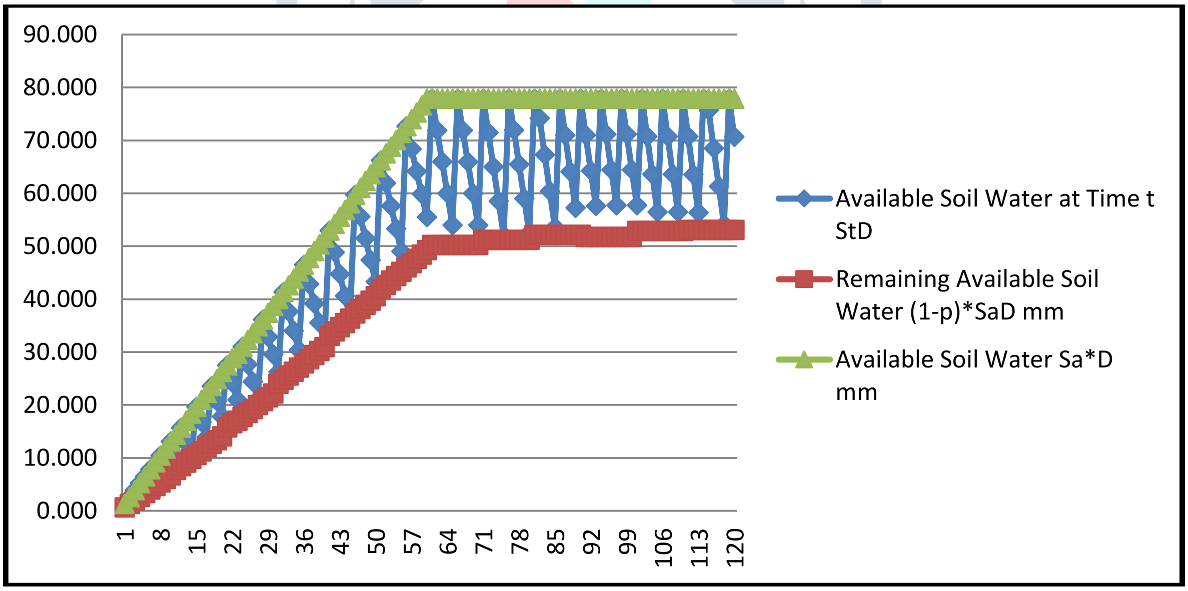

Fig 2 irrigation scheduling for summer paddy by water balance method

VI. CONCLUSION

From the above study, it is concluded that the Water Balance Method is more effective and efficient than the CROPWAT 9.0 for irrigation scheduling, only because whereas the earlier method used available soil water at time t over the effective root zone depth and remaining available soil water for irrigation scheduling, CROPWAT 9.0 used daily soil water available and readily available water for the same purpose. Moreover Water Balance Method calculates effective rainfall on daily basis which is not the case with CROPWAT 9.0.

ACKNOWLEDGMENT

Authors are extremely happy to acknowledge the help provided by the State Water Data Centre while furnishing the required data. Authors are very thankful to Professor A. L.Chalodiya of Navsari Agriculture University who has helped us a lot during our data collection for the present study.

REFERENCES

[1] H. Mehanuddin, G .Nikhitha, K. Prapthishree, L .Praveen, H. Manasa, 2018, Study On Water Requirement Of Selected Crops And Irrigation Scheduling Using Cropwat 8.0, International Journal Of Innovative Research In Science, Engineering And Technology, 7(4), 2347-6710.

[2] K. Nithya And A. Shivapur, 2016, Study On Water Requirement Of Selected Crops Under Tarikere Command Area Using Cropwat, Journal of irrigation and drainage engineering , 5(2) , 1-14.

[3] L.Ayu, H. Sebayang, Soemarno And S. Prijono, 2018, Assessment Of Rice Water Requirement By Using CROPWAT Model In Sumbawa Regency, West Nusa Tenggara, Indonesia , 31(2), 1-6.

[4] L. Shah, Dr. T. M. V. Suryanarayana and Dr. F. P. Parekh 2017, Determination Of Crop Water Requirement And Irrigation Scheduling For Banana, IJSRD - International Journal For Scientific Research & Development, 4(11), 2321-0613.

[5] L. Song, C.Oeurng, J. Hornbuckle, 2016, Assessment of Rice Water Requirement by Using CROPWAT Model, The 15th Science Council of Asia Board Meeting and International Symposium, 1-5.

[6] M.Haque, M. Najim, And T. Lee,2017, Modeling Irrigation Water Delivery Schedule For Rice Cultivation In East Coast Malaysia, Tropical Agricultural Research, 16(1), 204-213.

[7] M.Nyatuame, F.Ampiaw, V.Gyimah And B. Ibrahim, 2013, Irrigation Scheduling And Water Use Efficiency On Cabbage Yield", International Journal Of Agronomy And Agricultural Research (IJAAR), 3(5), -35.

[8] Ö.Çetn, O. Yildirim, D. Uygan And H. Boyaci, 2002 , Irrigation Scheduling of DripIrrigated Tomatoes Using Class A Pan Evaporation, Turk J Agric, 26(2) , 171-178

[9] P. Banik, N.K.Tiwari, And S. Ranjan, 2014, Comparative Crop Water Assessment Using Cropwat, International Journal Of Sustainable Materials, Processes & EcoEfficient – IJSMPE, 1(3), 2374 –1651.

[10] R. Domber, A.Kamble, R. Channagoudar, A. Janwade1 And S. Bhat,2009, Effect Of Irrigation Schedules And Mulches On Yield, Soil Temperature, Water Use And Economic Of Sunflower, International Journal Of Agricultural Sciences, June To December, 5(2), 459-462

[11] R. Mehta and V. Pandey, 2016, Crop water requirement (ETc) of different crops of middle Gujarat, Journal of Agrometeorology, 18 (1), 83-87.