Indian J.Sci.Res. 17(2): 186 - 189, 2018 ISSN: 0976-2876 (Print)
ISSN: 2250-0138(Online)

SPATIAL VARIATION OF IRRIGATION WATER REQUIREMENT IN AMARAVATHI SUB-BASIN

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Abstract - Globally growing demand for water has shown the need for its efficient and judicial utilization and particularly in agriculture being single largest consumer of water. Water is important for plant growth and food production and also there is a competition between municipal, industry users and agriculture for the finite amount of available water. Green water is the fraction of rainfall that infiltrates into the soil and is available to the plant growth. Green water is the largest fresh water resource, the basin of rain-fed agriculture and all life on land. The urgent need to focus on water investments in rain-fed agriculture leads to the conclusion that conventional water resource perceptions are incomplete. This recognition requires a widening of current agricultural water policy, which for decades has been skewed toward water for irrigation. The conventional water resource planning and management focus is on liquid water or blue water. Estimating irrigation water requirement is important for water project planning and management. Reaching higher irrigation efficiency proportional to best yields is one of the major challenges at near future. Maximizing the water productivity is the amount of crop per drop of water raises the agricultural yields through management that maximizes rainfall infiltration and minimizes non-productive green-water losses.

Evapotranspiration is a major component of hydrological cycle. Evapotranspiration varies for different vegetation types under different climate condition. By calculating evapotranspiration value precisely one can increase the efficiency of irrigation water allocation hence, an attempt was made to estimate the irrigation water requirement for major crops Paddy and Maize using the CROPWAT 8.0 for year 2011 and 2012. I am using metrological data (precipitation, temperature, humidity and wind speed) cropping pattern and cropping season in Amaravathi Sub basin and predict some results. Result, shows that irrigation water requirement for Paddy varies from 704.1mm to 1041.5mm for the year 2011 and for 2012 irrigation water requirement varies from 789.3mm to 932.09 mm. Irrigation water requirement for Maize varies from 205mm to 415.6mm in the year of 2011 and for the year of 2012 it varies from 318.2mm to 410.39mm. This variation of irrigation water requirement is due to the effective rainfall. The effective rainfall over the entire season is varying throughout the basin. Thus it makes difficult for the experts to find a proper irrigation schemes for the large scale projects.

Keywords: - Irrigation water requirement; Spatial Variation; Green Water; Evapotranspiration

I. Introduction

Serious water shortages are developing in many countries particularly in India and water for agriculture is becoming increasingly scarce in the light of growing water demands from different sectors (IWMI 2010). Agriculture is the largest (81%) consumer of water in India and hence more efficient use of water in agriculture needs to be top of most priority (Surendran*et al.,* 2013). Water is an essential input for crop production. Tamil Nadu received an average rainfall of 1304.1 mm during the year 2005-2006, which is higher by 36.1% over the normal rainfall of 958.5 mm (tn.gov.in 2007). But due to the uneven distribution of rainfall over spatial and temporal, low water holding capacity of soils are considered as the major limiting factors for higher productivity in the State.

Irrigation is the key input in crop production. Irrigated water has different functions such as, it acts as solvent for the nutrients, supplies moisture when it's essential, bacterial growth, etc. Plants use water for cooling purposes and the driving force of this process is prevailing weather conditions. Almost 90% of the global water consumption is for irrigation purposes, and more than 40% of the crops are produced under irrigated conditions. Adequate and timely irrigation leads to high yield. The major consumptive use of the irrigation water is evapotranspiration. Globally, 62% of the precipitation that falls on the continents is evapotranspirated. Out of this 97% is evapotranspirated from land surfaces and 3% is open air evaporation (Dingman, 2002). CROPWAT is a decision support tool developed by the land and water development division of FAO. CROPWAT 8.0 is a computer program for the calculation of crop water requirements and irrigation requirement based on soil, climate and crop data. In addition the program allows to development of the irrigation schedules for different management condition. CROPWAT works on the principle of Penman Monteith formula. which includes the calculation of the reference evapotranspiration based on the meteorological data.

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II. Study Area and Data Collection

Amaravathi watershed in Karur district lies between latitudes 10º 77' N and 10º 95' N and longitudes 77º 92' E and 78º 23' E. Amaravathi River is a tributary of Cauvery River which flows in Coimbatore and Tiruppur, Tamil Nadu, South India. The 175 km long Amaravathi River begins at the Kerala/Tamil Nadu border at the bottom of Manjampatti Valley between the Annamalai Hills and the Palani hills in Indira Gandhi Wildlife Sanctuary and National Park in Tiruppur. It descends in a northerly direction through Amaravathi Reservoir and Amaravathi Dam at Amaravathinagar.

Fig 1 : Amaravathi Basin with Rain Gauge stations

III. Experimental Views

A. Overview of the Model:

CROPWAT 8.0 for Windows is a computer programme for the calculation of crop water requirements and irrigation requirements from existing or new climatic and crop data. Furthermore, the program allows the development of irrigation schedules for different management conditions and the calculation of scheme water supply for varying crop patterns.

This Windows version is based on the DOS versions CROPWAT 5.7 of 1992 and CROPWAT 7.0 of 1999. Apart from a completely redesigned user interface, CROPWAT 8.0 for Windows includes a host of updated and new features.

These include the monthly, decade and daily input data for calculation of ET0. There is a possibility to estimate climate data in the absence of measured values. Decade and daily calculation of crop water requirement based on updated calculation algorithms including adjustment of crop co-efficient values. Graphical presentation of input data, crop water requirement and irrigation schedules. There will be a easy export/import of data and graphic through clipboard or ASCII text files.

B. Introduction to CROPWAT:

The main purpose of CROPWAT is to calculate crop water requirements and irrigation schedules based on data provided by the user. The data can be directly entered into CROPWAT or it is imported from the other applications. For the calculation of crop water requirements (CWR), CROPWAT allows the user to either enter measured ET0 values, or to input data on temperature, humidity, wind speed and sunshine, which allows CROPWAT to calculate ET0 using Penman-Monteith formulae. CROPWAT fully supports the PEN and CLI files from the CLIMWAT database.

Rainfall data are also needed, and are used by CROPWAT to compute effective rainfall data as input for the CWR and scheduling calculations. Finally, crop data (dry crop or rice) are needed for the CWR calculations and soil data if the user also wants to calculate irrigation schedules (dry crop or rice).whereas CROPWAT normally calculates CWR and schedules for one crop, it can also calculates a scheme supply, which is basically the combined crop water requirements of multiple crops, each with its individual planting date.

C. Programme Structure

The CROPWAT programme is organized in 8 different modules, of which 5 are data input modules and 3 are calculation modules. These modules can be accessed through the CROPWAT main menu but more conveniently through the module bar that is permanently visible at the left hand side of the main window. This allow the user to easily combine different climatic, crop and soil data for calculation of crop water requirement, irrigation schedules and schemes supplies.

D. Crop Water Requirement Estimation

The term crop water requirement is defined as the "amount of water required to compensate the evapotranspiration loss from the cropped field". "Although the values for crop evapotranspiration and crop water requirement are identical, crop water requirement refers to the amount of water that needs to be supplied, while crop evapotranspiration refers to the amount of water that is lost through evapotranspiration"[Allen et al. 1998]. FAO (2005) defined crop water requirement (CWR) for a given crop as:

$$ET_C = ET_0 \, X \, K_C \qquad \ldots\ldots \quad (1)$$

Where kci is the crop coefficient of the given crop i during the growth stage t and where T is the final growth stage. ETc = Kc *ETo where Kc = crop coefficient and ETo = reference crop Evapotranspiration (mm/day) is as defined in equation below as

$$ET_0 = \frac{0.408\,\Delta\,(R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34 u_2)} \qquad \ldots\ldots \quad (2)$$

Where ETo = reference evapotranspiration [mm day-1], Rn = net radiation at the crop surface [MJ m-2 day-1], G = soil heat flux density [MJ m-2 day-1], T = mean daily air temperature at 2 m height [°C], u2 = wind speed at 2 m height [m s-1], es =saturation vapour pressure [kPa], ea = actual vapour pressure [kPa], [es – ea] = saturation vapour pressure deficit [kPa],Δ =slope vapour pressure curve [kPa °C-1], γ = psychrometric constant [kPa °C-1]. The equation uses standard climatological records of solar radiation (sunshine), air temperature, humidity and wind speed. To ensure the integrity of computations, the weather measurements should be made at 2 m (or converted to that height) above an extensive surface of green grass, shading the ground and not short of water). The climatic data used for the calculations were collected from a meteorological station.

E. Effective Rainfall

Effective rainfall refers to that portion of rainfall that can effectively be used by plants. This is to say that not all rain is available to the crops as some is lost through Runoff (RO) and Deep Percolation (DP). This depends on the soil type, slope, crop canopy, storm intensity and the initial soil moisture content. Small amount of rainfall are not very effective as these small quantities of water are quickly lost to evaporation.

CROPWAT 8.0 offers the possibility to use several methods to calculate the effective rainfall:

- Fixed percentage of rainfall.
- Dependable rain.
- Empirical formula.
- USDA soil conservation service method.

For calculating the effective rainfallI had used the dependable rainfall method:

Monthly step:

Peff = 0.6 * P - 10 for Pmonth <= 70 mm.

Peff = 0.8 * P - 24 for Pmonth > 70 mm.

F. Irrigation Water Requirement

Irrigation is required when rainfall is insufficient to compensate for the water lost by evapotranspiration. The primary objective of irrigation is to apply water at the right period and in the right amount. By calculating the soil water balance of the root zone on a daily basis, the timing and the depth of future irrigations can be planned.

$IWR = ET_C$ – effective rainfall …….. (3)

III. Spatial Variation of Irrigation Water Requirement

By using the CROPWAT model the irrigation water requirement for the crop paddy and maize was calculated for the year of (2011 &2012). By using the Arc GIS the spatial variation of the irrigation water requirement is done by using the interpolation method Inverse Distance Weightage method.

A. Paddy Crop (Kharif) 2011

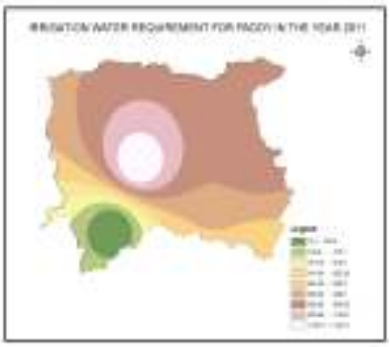

Fig 2 :Irrigation Water Requirement For Paddy in the year 2011

From the above figure 2 it is noted that the irrigation water requirement for paddy varies from 701 mm to 1041.5 mm over the entire for kharif crop paddy in the year of 2011.

B. Paddy Crop (Kharif) 2012

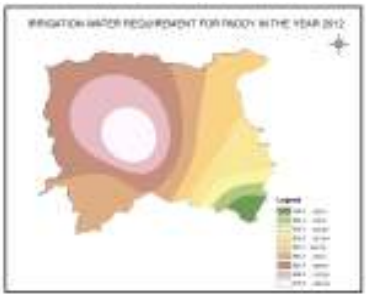

Fig 3 :Irrigation Water Requirement for Paddy in the year 2012

C. Iwr For Maize (2011)

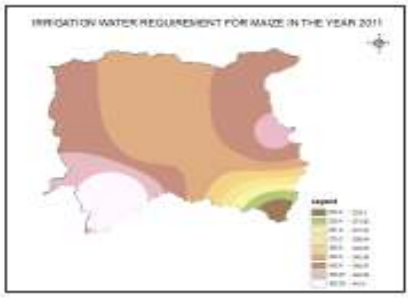

Fig 4 : Irrigation Water Requirement for Maize 2011

From the above figure 4 the irrigation water requirement for maize varies from 205.0 mm to 415.6 mm over the entire basin in the year of 2011.

D. Iwr For Maize 2012

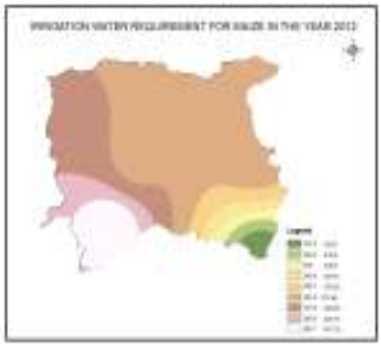

Fig 5 :Irrigation Water Requirement for Maize in 2012

From the above figure 5 the irrigation water requirement for maize varies from 318.2 mm to 410.39 mm over the entire basin in the year of 2012

IV. Conclusion

Irrigation water requirement involves in making a decision on how much water need for the crop, irrigation scheduling and when to apply it. In this chapter it determines the evapotranspiration for paddy and maize crops. The model is used to estimate the evapotranspiration (ET) for paddy and maize by using CROPWAT 8.0 and spatial variation of irrigation water requirement was done by using Arc GIS.

In present study, it can conclude that, the decreasing of ETo value is due to the increase in rainfall. The maximum irrigation water requirement for paddy is 1041.5 mm and the maximum water requirement for maize is 415 mm in the year of 2011. By calculating the irrigation water requirement various management practise can be done. It allows the development of recommendation for improved irrigation practise and planning the irrigation schedule only to the small scale.

The spatial variation in the irrigation water requirement in the present study states that irrigation water requirement for the entire sub basin varies. The proper recommendation for the basin is very difficult due to the varieties of crop change in cropping pattern. The above constraints are one of the factor for the failure most of the irrigation projects.

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