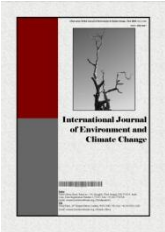

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# Water Requirement of Selected Crops for Sangareddy District of Telangana Using CROPWAT 8.0

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The precise selection of appropriate crops that are compatible with the soil and crop water requirements (CWR) in a particular area is necessary for effective land and water management. A study was conducted to ascertain the agricultural water requirements of a few chosen crops for the Sangareddy District of Telangana. The crops include Rice, Sugarcane, Soybean, Maize, Cotton, Black gram, Green gram, and Bengal gram. Using meteorological data from the past 10 years stored in CROPWAT, the amount of water needed by each crop was calculated. The FAO Penman-Monteith method was used to determine reference crop evapotranspiration ($ET_0$). The study shows that reference crop evapotranspiration, ETo varied from 7.96 mm/day to 3.14 mm/day in the years between 2010 – 2021. The crop water requirement (CWR) and Net irrigation requirement for Rice were 595.5 mm and 331.9 mm, Maize was 366.6 mm and 64.3 mm, Cotton was 612.7 mm and 283.8 mm, Sugarcane was 1902.1 mm and 1189.3 mm, Soybean was 270.9 mm and 0.0mm, the Black gram was 332.1 mm and 22.1 mm, Green gram was 342.7 mm and 13.3 mm and Bengal gram was 344.9 mm and 316.1 mm. The results were accurate $R^2$ was 0.84 compared with the Class A pan. This study demonstrates that the CROPWAT model is helpful for computing the crop water requirement which needs for the appropriate administration of water assets.

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## 1. INTRODUCTION

Both the development and food production of plants depend on water. Competition exists between municipal and industrial and agricultural users who rely on the water stored in reservoirs. Estimating Planning for water projects must take into account the need for agricultural water, and administration [1]. Applying water is irrigation's main goal. When crop evapotranspiration (ETA) requirements are met by adding water to the soil rainfall is not enough to sustain crops until harvest. The entire amount of water required for evapotranspiration, in a certain climate regime, from planting through harvest for a particular crop, when irrigation or rains maintain sufficient soil moisture, that agricultural productivity and plant development are unaffected [2].

Thus, the total of the individual crop water requirements (CWR) determined for each irrigated crop is the net irrigation water requirements (NIWR) under a particular scheme for a given year. In order to automatically account for multiple cropping (several cropping periods per year), the crop water requirements for each cropping phase are individually calculated [3,4]. A value for the irrigation water requirements is produced by dividing the scheme's area, and it can be represented in mm. According to FAO, Smith et al., and Smith, CROPWAT is intended to be a useful tool for agro meteorologists, agronomists, and irrigation engineers to use for estimating evapotranspiration and crop water usage studies, and more particularly when designing and managing irrigation schemes [5]. This can lead to recommendations for better irrigation techniques, the design of irrigation schedules under various water supply situations, and the evaluation of production under rain-fed or deficit irrigation. Environmental factors affect how much water crops need [6-9]. Under the same meteorological circumstances, various crops require different amounts of water [10]. When the soil water level is at the field's maximum, crops will transpire water at the fastest rate possible. In particular, during drought years, the seasonal crop water requirements is essential for planning your mixed crop planting [4]. In poor nations around the world, there is a lack of adequate data on the irrigation water requirements of the majority of crops [9,11]. This is one of the reasons why most large-scale irrigation projects around the world fail in underdeveloped nations [12-14]. Determine the crop water needs for Rice, Sugarcane, Soybean, Maize, Jowar, Cotton, Black gram, Green gram, and Bengal gram.

## 2. MATERIALS AND METHODS

### 2.1 Study area

The study was conducted in Telangana, Sangareddy district which is located at 17°36'41.2644” N and 78°4'54.5160” E with an altitude of 496m and has an estimated population of 15,27,628 according to the 2011 Census of India. The Sangareddy district has an area of 4,464.87 sq km and the district has a gross cropped area, net cropped area, gross irrigated area, and net irrigated area of 265290, 234478, 61051, and 45797 respectively (in hectares).

### 2.2 Data Required for Study

The following data was required for the calculation of the water requirement study as shown in Table 1.

### 2.3 Actual Evapotranspiration Calculated by the FAO Penman-Monteith Method

The FAO Penman-Monteith method included the calculation of actual evapotranspiration (ETc) that was estimated from the product of the crop coefficient (Kc), the soil coefficient (Ks) and the reference crop evapotranspiration (ETo) using equation 1.

$$ETc = Kc \times ETo \quad (1)$$

The reference crop evapotranspiration (ETo) can be calculated on a daily basis using equation 5, the FAO Penman-Monteith equation (Allen, 1998).

$$ETo = \frac{0.408\Delta(Rn-G)+\gamma\frac{900}{T+273}u(es-ea)}{\Delta+\gamma(1+0.34u2)} \quad (2)$$

Where,

$ETo$ = reference evapotranspiration, mm day$^{-1}$;

$Rn$ = net radiation at the crop surface, MJ m$^{-2}$d$^{-1}$;

G = soil heat flux density, MJ m-2d$^{-1}$;

T = mean daily air temperature at 2 m height, °C;

$u2$ = wind speed at 2 m height, $ms^{-1}$

$es$ = saturation vapor pressure, kPa;

$ea$ = actual vapor pressure, kPa;

$es - ea$ = saturation vapor pressure deficit, kPa;

The effective rainfall calculation in FAO employed many methods, out of which for the present study USDA soil conservation service method is selected, which is illustrated as below:

$$Peff = \frac{[P \times (125 - 0.2 \times P]}{125} \; for \; P \leq 250 \; mm \quad (3)$$

$$Peff = 125 + 0.1 \times P \; for \; P > 250 \; mm \quad (4)$$

### 2.3.1 CROPWAT

The FAO Penman-Monteith approach was used to construct the CROPWAT programme, which was used to calculate the crops' water needs. The meteorological measurements were taken at a height of 2 m (or converted to that height) above the level of the green grass shadowing the ground in order to assure the accuracy of computations [15]. The computations' climatic information came from a District head office-based meteorological station.

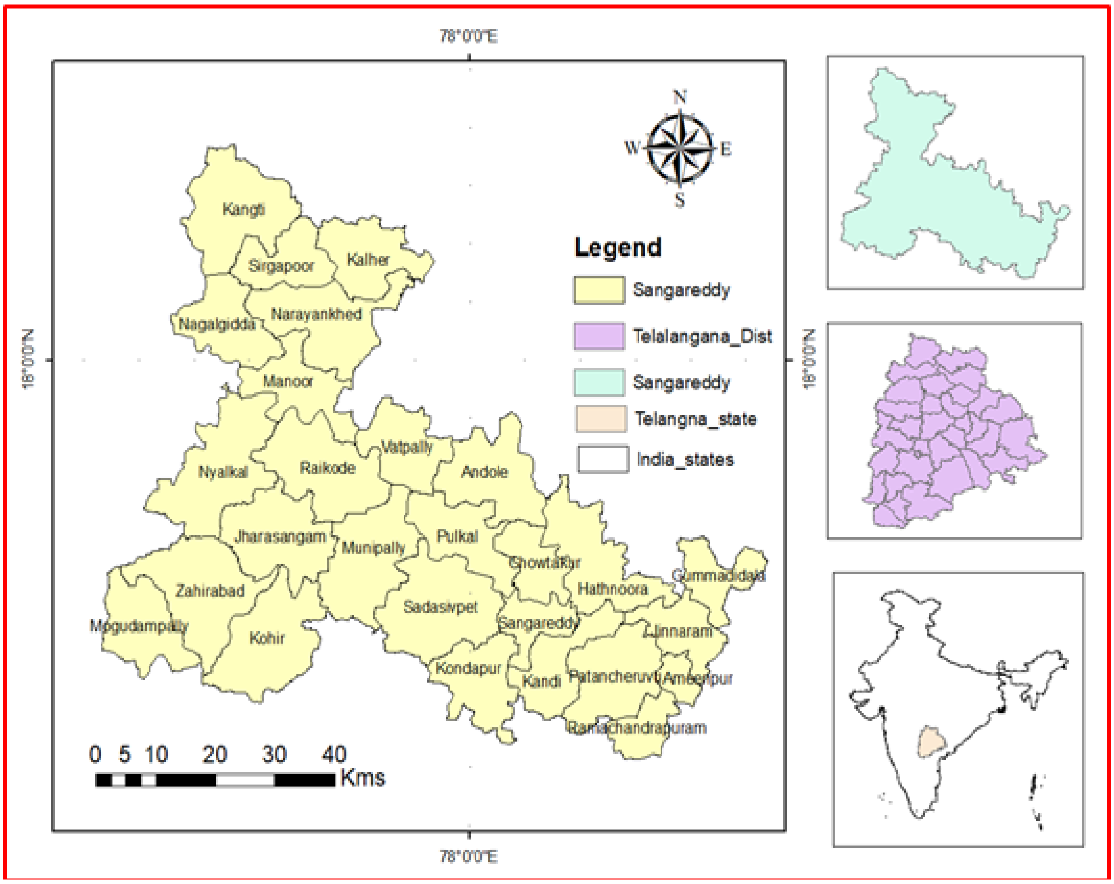


**Fig. 1. Location map of the Study area**

**Table 1. Data required for the study**

| S. No. | Data | Time Period | Source |
|---|---|---|---|
| 1. | Meteorological data | 2010-2021 | Collectorate Office Sangareddy |
| 2. | Rainfall data | 2010-2021 | Collectorate Office Sangareddy |
| 3. | Soil data | 2010-2021 | Agriculture Department Sangareddy |
| 4. | Cropping Pattern data | 2010-2021 | Agriculture Department Sangareddy |

## 3. RESULTS AND DISCUSSION

The water requirement was calculated for some of the selected crops in the study area and was presented in this results and discussion chapter.

### 3.1 Reference Evapotranspiration

The simulated values of reference evapotranspiration (ETo) through the CROPWAT 8.0 model using FAO Penman-Monteith equation, for the Sangareddy district of Telangana along with the meteorological parameters and monthly distribution of reference evapotranspiration as shown in Table 2. The maximum ETo was found at 7.96 mm/day in May, which was mainly due to high temperature and wind velocity, whereas the minimum was 3.14 mm/day in September.

### 3.2 Effective Rainfall

Various techniques (fixed proportion, empirical formula, dependable rain and techniques used by the USDA Soil Conservation Service) 8.0 model of CROPWAT for evaluating the effective rainstorm. In the dry season, there is no recorded rainfall (October through May). The effective rainfall during the rainy season is Due to the losses, just 49–87% of the rainfall occurred. ET0 is lower while it's raining compared to the fall and winter seasons. July, August, and Sep month, it can be seen that ET0 fluctuates with regard to effective rainstorms.

### 3.3 Crop Water Requirement (CWR) and Net Irrigation Requirement for Selected Crops

The crop water requirement (CWR) and Net irrigation requirement for Rice were 595.5mm and 331.9 mm, Maize was 366.6 mm and 64.3 mm, Cotton was 612.7 mm and 283.8 mm, Sugarcane was 1902.1 mm and 1189.3 mm, Soybean was 270.9 mm and 0.0mm, the Black gram was 332.1 mm and 22.1 mm, Greengram was 342.7 mm and 13.3 mm and Bengal gram was 344.9 mm and 316.1 mm as presented in Table 3 [16], Abirdew, 2017, Desta et al., [17] and Kirnak et al., [18].

**Table 2. Reference evapotranspiration along with meteorological parameters of the study area**

| Month | Min Temp °C | Max Temp °C | Humidity % | Wind km/day | Sun hours | Rad MJ/m²/day | ETo mm/day |
|---|---|---|---|---|---|---|---|
| January | 15.6 | 30.6 | 62 | 147 | 7.5 | 16.6 | 3.79 |
| February | 19.4 | 30 | 50 | 164 | 7.7 | 18.5 | 4.58 |
| March | 24.1 | 32.9 | 42 | 164 | 8.6 | 21.6 | 5.67 |
| April | 27.6 | 41.5 | 50 | 190 | 7.3 | 20.7 | 6.7 |
| May | 30.0 | 43.6 | 52 | 285 | 6.3 | 19.3 | 7.96 |
| June | 28.1 | 38.8 | 76 | 432 | 3.5 | 15.0 | 5.74 |
| July | 25.4 | 34.6 | 80 | 406 | 1.7 | 12.3 | 4.32 |
| August | 24.3 | 32.4 | 88 | 380 | 2.9 | 13.9 | 3.60 |
| September | 23.4 | 29 | 89 | 268 | 3.3 | 13.9 | 3.14 |
| October | 20.1 | 29.8 | 73 | 190 | 5.3 | 15.6 | 3.85 |
| November | 18.4 | 28.7 | 63 | 164 | 6.1 | 15.1 | 3.73 |
| December | 16.3 | 28.1 | 62 | 147 | 7.4 | 15.9 | 3.51 |

**Table 3. Crop Water requirement (CWR) and effective rainfall for selected crops**

| S. No | Crops | CWR (mm) | Effective rainfall (mm) | Irri. Req. (mm) |
|---|---|---|---|---|
| 1 | Rice | 595.5 | 874.2 | 331.9 |
| 2 | Maize | 366.6 | 287.3 | 64.3 |
| 3 | Cotton | 612.7 | 478.1 | 283.8 |
| 4 | Sugarcane | 1902.1 | 1030.0 | 1189.3 |
| 6 | Soybean | 270.9 | 304.1 | 0.0 |
| 7 | Black gram | 332.1 | 296.9 | 22.1 |
| 8 | Green gram | 342.7 | 326.7 | 13.3 |
| 8 | Bengal gram | 344.9 | 29.8 | 316.1 |

## 4. CONCLUSION

The FAO CROPWAT model for the Penman-Monteith method was used to determine reference crop evapotranspiration ($ET_0$). The study shows that reference crop evapotranspiration, ETo varied from 7.96 mm/day to 3.14 mm/day in the years between 2010 – 2021. The crop water requirement (CWR) and Net irrigation requirement for Rice was 595.5mm and 331.9 mm, Maize was 366.6 mm and 64.3 mm, Cotton was 612.7 mm and 283.8 mm, Sugarcane was 1902.1 mm and 1189.3 mm, Soybean was 270.9 mm and 0.0mm, Black gram was 332.1 mm and 22.1 mm, Green gram was 342.7 mm and 13.3 mm and Bengal gram was 344.9 mm and 316.1 mm.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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