Assignment 1b   Prof. M.M.M. Najim

Acknowledgement: This assignment is modified from Dr. Derek Clarke's assignment that is used in Southampton University, UK. Dr. Derek Clarke's permission to use this assignment with modifications in teaching in Sri Lanka is highly acknowledged.

Entering data and calculating Crop Water Requirements

Aims :
To calculate the crop water needs for a crop of Maize (grain) near Mahailuppallama.

1- learn what data is needed to calculate Crop Water Requirements using CROPWAT
2- enter a set of data for a site in Mahailluppallama
3- save the data in the correct directories
4- calculate the Crop Water Requirements for one crop

Data available :
Country : Sri Lanka, Station Mahailuppallama. Altitude 95 meters.
Latitude 8.22 Deg. North, Longitude 80.28 Deg. East
Average monthly climate data at a site 20 km from the project area - see **Table 1**
Monthly rainfall data for the area - see **Table 1**.

Other data :
No crop coefficient data is available for the Maize variety grown in Sri Lanka.
 (See **Table 2** for FAO crop coefficients for a typical variety of Maize.)
No planting dates. You will have to select the planting date.
Limited soil information ("a medium to light soil")
No information on the type of irrigation to be used.

Method :

Use CROPWAT for Windows to
-        Enter climatic data and calculate <u>reference crop evapotranspiration</u> using the FAO Penman-Montieth equation.
-        Enter rainfall data and estimate <u>Effective Rainfall</u>. (Note , you should try several of the Effective Rainfall equations because they can give quite different results.)
-        Enter the <u>crop coefficient</u> data into Cropwat for Windows and save in a file called mi.CRO
-        Define a <u>cropping pattern</u> (crop, planting date)
-        Calculate Crop Water Requirements with different planting dates, and effective rainfall. Compare the differences between results for different planting dates.

Table 1 : Monthly climatic data for climate station in Mahailuppallama

Month	MaxTemp (deg.C)	MiniTemp (deg.C)	Humidity (%)	Wind Spd (Km/d)	SunShine (Hours)	Rainfall mm/month
January	26.8	23.4	79	71	8	269.0
February	27	25.6	70	75	10.1	180.0
March	29.3	27.3	67	76	9.7	89.0
April	30.9	27.7	75	73	8.9	70.0
May	29.5	27.9	80	90	7.9	53.0
June	29.6	27.8	78	163	8	22.0
July	31	27	75	210	9	43.0
August	30.7	27.1	76	172	7.2	47.0
September	30.1	28.1	72	155	8.1	54.0
October	29.8	26.8	75	163	7.5	146.0
November	29.3	25.1	81	93	6.2	282.0
December	28.5	24.1	85	48	6.7	373.0

Table 2: FAO Crop data for Maize (grain)

Growth Stages	Initial	Development	Mid	Late	Total
Stage Lengths [Days]	25	40	40	30	135
Crop Coefficients (Kc)	0.3	>>>	1.2	0.5	
Rooting Depths [m]	0.3	>>>	1	1	
Depletion Levels	0.5	>>>	0.5	0.8	
Yield Response Factors	0.4	0.4	1.3	0.5	1.25
Crop height (m)			2.0		

Reminder - What data do we need to calculate crop water requirements?

1   The location of the project
        Latitude - used in calculating day length and solar radiation on the Penman Monteith equation. Altitude is also used to estimate air pressure if the project area is at a high altitude.

2   Measured evaporation data or climatic data to estimate ETo with Penman Monteith.
        Temperature
        Humidity
        Wind speed
        Sunshine hours

3   Rainfall
        Date and rainfall amount
        This will be reduced to "Effective rainfall" by Cropwat

4   Crop Coefficient data (Kc)
        Stage length
        Crop coefficient

("P" fraction and yield reduction data are not needed for crop water requirements calculations, but they are needed for irrigation scheduling. The same is true for soil data. The next exercise will be to calculate an irrigation schedule for this crop.)

5   Planting date and area cropped

We will be using Maize so the planting date will be some time in Yala season or in Maha season. You should try several planting dates in both seasons to see the effect on crop water requirements because rainfall and ETo will change during the growing season.

Notes :

The data for our project in Sri Lanka data is monthly averages, so we will have to convert this to a shorter time step such as daily or weekly to make our calculations. Fortunately Cropwat for Windows will do this for us.

It is important to remember that the climate data in **Table 1** is for the long term average. Irrigation projects are usually designed to cope with dry years, say the 1 in 4 or 5 year drought, so it is important to think about dry years. In some cases it may be prudent to assume no rainfall at all in the growing season.

METHOD : (HOW TO DO IT)

1   Start CropWat for Windows on your computer.

2   In the main menu bar at the top of the screen, select **File, New Session.** Then, from the left side menu, select **Climate/ETo.** You will see a window to enter the monthly climate data for different months. Fill in the data table.

CROPWAT - Session: untitled

Monthly ETo Penman-Monteith - C:\ProgramData\CROPWAT\data\climate\MI.PEM

Country Sri Lanka   Station Mahailuppallama

Altitude 95 m.   Latitude 8.22 °N   Longitude 80.28 °E

Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	hours	MJ/m²/day	mm/day
January	23.4	26.8	79	71	8.0	19.5	3.72
February	25.6	27.0	70	75	10.1	23.8	4.59
March	27.3	29.3	67	76	9.7	24.3	5.03
April	27.7	30.9	75	73	8.9	23.2	5.00
May	27.9	29.5	80	90	7.9	21.1	4.55
June	27.8	29.6	78	163	8.0	20.8	4.66
July	27.0	31.0	75	210	9.0	22.4	5.21
August	27.1	30.7	76	172	7.2	20.2	4.73
September	28.1	30.1	72	155	8.1	21.7	5.06
October	26.8	29.8	75	163	7.5	20.1	4.62
November	25.1	29.3	81	93	6.2	17.1	3.65
December	24.1	28.5	85	48	6.7	17.3	3.43
Average	26.5	29.4	76	116	8.1	21.0	4.52

ETo file	Rain file	Crop file	Soil file
mi.pem			

3.   Once you enter all the data for a month, the CropWat will calculate Radiation and evapotranspiration.

4.   Save the Climatic data entered and ET_o calculated by pressing save icon on the main menu giving an appropriate file name (i.e MIRF)

5.   Then, select **Rain** from the left side menu to enter rainfall data.

6.   In the Monthly Rainfall window, enter the name of the rain gauging station. The CropWat by default gives an effective rainfall calculation method. Once the rainfall data is entered, the CropWat calculates the effective rainfall based on the effective rainfall calculation method.

7   Save the Rainfall data entered and Effective Rainfall calculated by pressing save icon on the main menu giving an appropriate file name. (You may give the same file name as the files are saved with a different file extension)

8   Now we have to define the crop coefficients. Select **Crop** from the left side menu to enter crop data. Name the crop and give the planning date.
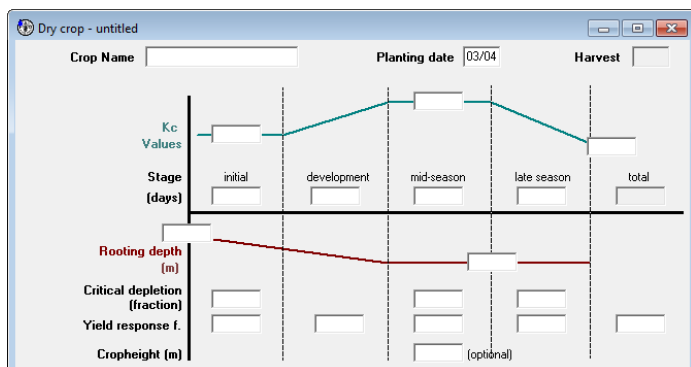
9.   Enter the length of the four growing stages and the three values of crop coefficient from **Table 2**. It will also be useful to enter the other data – rooting depth, critical depletion fraction, and yield response and crop height for the crop (optional).

10.   Enter the planting date. Based on the duration of the crop, the CropWat calculates the harvesting date.

11.   Save the crop data entered by pressing save icon on the main menu giving an appropriate file name.

12.   Now, you can calculate crop water requirement. Select **Calculations** from main manu and the select **crop water requirements**.

13.   Now we have to define the soil characteristics. Select **Soil** from the left side menu to enter soil data. Name the soil and enter the soil data (RED LOAMY, total available soil moisture 180 mm/m, max. rain infiltration rate 30 mm/day, maximum rooting depth 900 cm, initial soil moisture depletion 0, initial available soil moisture 180 mm/m). OR Open soil data file by clicking the **Open icon** from the main menu .

14.   Save the soil data entered by pressing save icon on the main menu giving an appropriate file name.

The next step is to define the cropping pattern - i.e. what crops are grown and when those are planted.

15.   To enter the cropping pattern select **Crop Pattern icon** from the left side menu. Name the cropping pattern, select crop files (you have developed only one file, that is for Maize), planting date and % of total area cultivated by that crop.

For this step, you may consider Maize crop is grown as follows

Crop	Planting Date	Percentage of total area cultivated
Maize	03/04	25%
Maize	03/05	25%
Maize	03/06	25%
Maize	03/07	25%

16. Save the cropping pattern entered by pressing save icon on the main menu giving an appropriate file name.
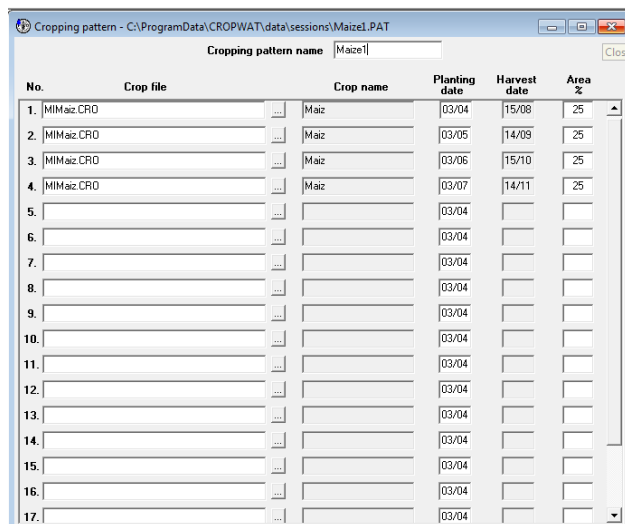
You have now entered all the necessary data to make a first estimate of the crop water requirements. CropWat will now do the following :

- Calculate monthly ETo using the Penman Monteith equation
- Smooth the monthly ETo values into daily values by fitting a curve
- Smooth monthly rainfall data into daily values
- Calculate rainfall events for each month
- Calculate the effective rainfall for each event using the USDA method
- Calculate Crop Water Requirements using CWR=ETo*Kc*area planted
- Calculate Irrigation Water Requirement using IWR=CWR-Effective Rain
- Calculate Field Water Supply FWS in litres/seconds/hectare

17. You can now look at the results by selecting the following from the Menu at the left hand side:
    a. Pressing the icon **CWR** - ET_c, Effective rainfall and Irrigation Requirement
    b. Pressing the icon **Schedule** – Irrigation schedule with Net and Gross irrigation, losses, effective rainfall, yield reduction
    c. Pressing the icon **Scheme** – Net scheme irrigation requirement, irrigated area

Note that the calculations have been done in steps of 10 days, but you can change this if you wish.

Also note that Cropwat has assumed that the infield efficiency of irrigation is 70%. This efficiency is used to convert crop water requirements in mm/day into the equivalent of liters of water per second per hectare. Again you can change the infield efficiency if you want to.

Scheme Supply

ETo station: Mahailuppallama
Rain station: Mahailuppallama

Cropping pattern: Maize1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation deficit												
1. Maiz	0.0	0.0	0.0	0.0	45.8	126.9	116.0	18.1	0.0	0.0	0.0	0.0
2. Maiz	0.0	0.0	0.0	0.0	2.5	73.7	128.5	100.0	15.9	0.0	0.0	0.0
3. Maiz	0.0	0.0	0.0	0.0	0.0	18.8	66.0	113.4	95.3	0.0	0.0	0.0
4. Maiz	0.0	0.0	0.0	0.0	0.0	0.0	6.1	58.0	107.7	28.6	0.0	0.0
Net scheme irr.req.												
in mm/day	0.0	0.0	0.0	0.0	0.4	1.8	2.6	2.3	1.8	0.2	0.0	0.0
in mm/month	0.0	0.0	0.0	0.0	12.1	54.9	79.2	72.4	54.7	7.2	0.0	0.0
in l/s/h	0.00	0.00	0.00	0.00	0.05	0.21	0.30	0.27	0.21	0.03	0.00	0.00
Irrigated area	0.0	0.0	0.0	0.0	50.0	75.0	100.0	100.0	75.0	25.0	0.0	0.0
(% of total area)												
Irr.req. for actual area	0.00	0.00	0.00	0.00	0.09	0.28	0.30	0.27	0.28	0.11	0.00	0.00
(l/s/h)												
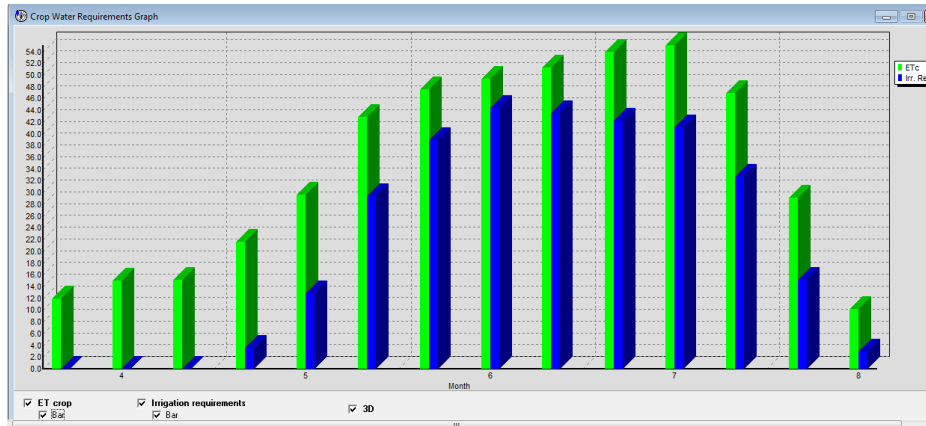
18. Charts on Climate/ET$_o$/Rain, crop water requirements and irrigation schedule can be viewed by selecting **Charts** from main menu and relevant items from the list.
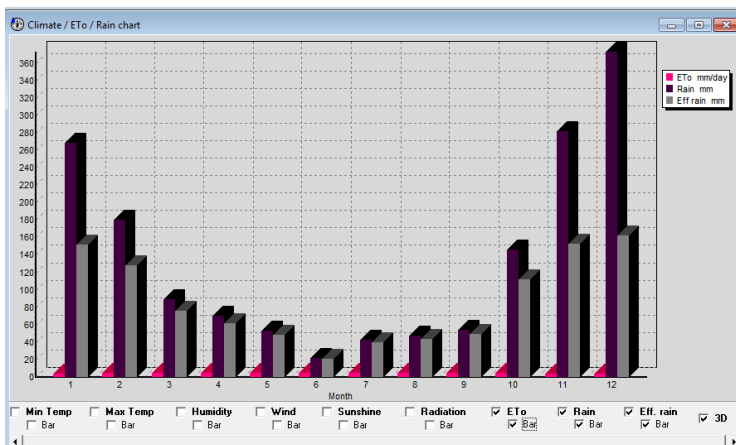
23 You should now try the following:

- Change the planting date to one month earlier or one month later. This will change the time of peak crop water requirement and the rainfall may have a bigger or smaller effect.

- Change the effective rainfall method (select **Settings, Options, Rainfall and different methods**). This can have a big effect on the Irrigation Water Requirements.