

Assessment actual evapotranspiration with R program

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Abstract. The aim is an assessment of the actual evapotranspiration of plants by using climate data in Nakhon Ratchasima with the R in the hydrological modeling function of Abteu and Morton CRAE formulation. There are using meteorological data from 2012 - 2016 at Nakhon Ratchasima station. The case analysis shows the results of evapotranspiration are the potential of evaporation of plants each year. Abteu analysis gave higher monthly evapotranspiration results during the dry season than Morton CRAE, but with Abteu formulation gave lower monthly evapotranspiration results during the rainy season than that of the method. The results are 2 ways to use evapotranspiration for water management, which is to analyze the amount of evapotranspiration for use in irrigation systems in order to water for plants should use the form of Abteu form because it can be seen that during the dry season and the plant has a high evapotranspiration value. Form Morton CRAE should be used to assess the potential water use of plants that can be seen in the dry season, the evaporation of plants is also less because in the surrounding environment there isn't water and has little moisture causing plants to use less water.

1 Introduction

The current climate has a huge impact on countries that produce food to feed the world. Especially in the area of Thailand, which is considered a food-producing country, export to take care of the population in many countries such as Japan, China, America, and ASEAN. Economics for Agriculturist in Thailand [1] has shown the agricultural situation from the past to the present that technology and innovation should be used to increase productivity per unit area with climate control. Agriculture products in Thailand are rice, rubber, tapioca, and processed food, which can be processed into a variety of food. We cannot control the effects of climate that have changed. Preparing to cope with the changing conditions that are necessary for the analysis to be accurate and to consider the changing conditions in all aspects. Therefore, changing weather factors should be used in limited water management.

Plants are the main consumers of water use, both natural water sources such as rain, ravines, swamps, lakes, as well as the pleasure in the soil. And water resources that humans

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are allocated to include irrigation water. We cannot deny that plants are the main organisms that we should focus on. Humans and animals are all-consuming plants as the main food. In this situation, changing weather will affect the water consumption of plants. When the weather is hot, high-temperature evaporation and water loss are also high. When the amount is available during the dry season and lacking rain to come to the original water source or soil moisture will cause plants to lack water. The growth stops and eventually dies without moisture. We can see clearly during the dry season in Thailand, which often faces drought and damaged crops. Farmers have suffered, production costs are higher in value but less in quantity.

For analyzing the water usage of plants, the most important factor that must be considered is the evaporation calculation. At present, the Office of Water Management and Hydrology (Royal Irrigation Department in Thailand) [2] reported evaporation of plants is used to calculate the water demand of plants which is widely used. Such calculation results require weather data to be used for analysis such as temperature, relative humidity, sunshine hours, wind speed, etc. These factors have changed and there are unique in each area. In this study is an analysis of volatile emission estimates by using the correlation model of hydrological data with R program in the hydrological model function of Abteu and Morton CRAE formulation, using meteorological data from 2012 - 2016 to study the changes in plant evaporation in Nakhon Ratchasima province. The method was in the agreement with the research from an earlier study [3].

2 Materials and methods

Materials and methods for assessment actual evapotranspiration with R program is calculated using climate data with the program which can be described as follows.

2.1 Materials

Package "Evapotranspiration" [4] is a database calculation method based on data from Penman, Penman-Monteith, FAO 56, Priestley-Taylor and Morton formulations with the usage characteristics of the instruction set, including.

ET (data, constants, ts="monthly", est="potential ET", solar="sunshine hours", Tdew=T, alpha = NULL, message="yes", AdditionalStats="yes", save.csv="yes", ...).

2.2 Methods Input data

The characteristics of the data used in the analysis to avoid confusion will be presented in the form that must be used in the analysis of writing a set of instructions and data preparation consisting of Tmax, Tmin (degree Celcius), Rs (Megajoules per sqm) or n (hour) or Cd (okta) daily 2012 - 2016 and use various constants including

1. Elev - ground elevation above mean sea level in m,
2. lambda - latent heat of vaporisation = 2.45 MJ/kg,
3. lat_rad - latitude in radians,
4. Gsc - solar constant = 0.0820 MJ/m²/min,
5. sigma - Stefan-Boltzmann constant = 4.903*10⁻⁹ MJ/K⁴/m²/day,
6. as - fraction of extraterrestrial radiation reaching earth on sunless days,
7. bs - difference between fraction of extraterrestrial radiation reaching full-sun days and that on sunless days.

2.3 Input data

1. Proceed to prepare the import data for the model 2012-2016, including Year Month Day Tmax.daily Tmin.daily Tdew.daily n.daily RHmax.daily RHmin.daily uz.daily
2. Importing data in the form of text documents (.txt) files for convenience by suggesting to create data files in the form of Microsoft Excel Worksheet (.xlsx) files converted to .xlsx data files in .txt file for the model to read information
3. Write a command to read data using the table name as named and change the specific values to use the calculation data in the study area and display Abtew and Morton CRAE formulation as follows

```
# Change some data
> constants$lat <- 14.6333333 # degree
> constants$lat_rad <- 0.255399847 # radian
> constants$Elev <- 386.12 # m
> constants$z <- 11 # m
> constants$PA <- 1163.0 # mm
# Call ET.MortonCRAE
> Morton <- read.table("climate_2012-2016.txt", header = TRUE)
> Data <- ReadInputs(Morton,constants,stopmissing=c(10,10,3), timestep = "daily")
> Results <- ET.MortonCRAE(Data, constants, ts="monthly", est="actual areal ET",
  solar="sunshine hours", Tdew=TRUE, alpha = NULL)
#Abtew
> Abtew <- read.table("climate_2012-2016.txt", header = TRUE)
> Data <- ReadInputs(Abtew,constants,stopmissing=c(10,10,3),timestep = "daily")
# Call ET.Abtew
> Results <- ET.Abtew(Data, constants, est="actual areal ET", ts="daily",
  solar="sunshine hours")
```

3 Results and discussion

3.1 Annual actual ET

Annual evapotranspiration analysis using the R program using the Abtew and Morton CRAE formulation methods with the analysis data for the year 2012-2016 in the Meteorological Station area of Nakhon Ratchasima province. The monthly changes in each year can be displayed using the Model R as shown in Table 1. The Abtew study has the highest evaporation rate in 2015 equal to 1,340.04 mm./year. For Morton CRAE there is the highest evaporation rate in 2016 is 1,389.21 mm./year.

Table 1. Annual actual evapotranspiration.

Year	ET (mm/year)	
	Abtew	Morton CRAE
2012	1,256.47	1,288.13
2013	1,265.56	1,355.75
2014	1,287.88	1,226.42
2015	1,340.04	1,313.46
2016	1,286.19	1,389.21

3.2 Monthly actual ET

The results of the study with the Abtew method show the trend of daily change, the average of each year is high during the dry season or there is little rainfall. Including the period from March to May, evapotranspiration values are higher than 4 mm per day and will have low amounts during the rainy season or high rainfall from August to October. Most evapotranspiration values are between 3-4 mm. Evapotranspiration results show that the highest evapotranspiration potential is 143.41 mm in April 2016 and the lowest evapotranspiration potential is 79.73 mm in September 2013. Results can be displayed for individual evapotranspiration analysis. Average daily evapotranspiration shows in Table 2 and monthly evaporation rates as in Figures 1 and 2.

The results of the Morton CRAE study show that the trend of daily changes in average is high each year during the rainy season or the soil has a high moisture content. Including the period from June to October, more evapotranspiration values are higher than 4 mm per day and will have low amounts during the dry season or little rainfall from November to May. Most evapotranspiration values are between 1.5-4 mm per day. The result analysis showed that the highest evapotranspiration potential was 186.23 mm in September 2013 and the lowest evapotranspiration potential of the month is 21.07 mm in December 2014. The emission analysis results can be displayed average daily values as in Table 2 and monthly evaporation rates as in Figures 1 and 2.

Table 2. Daily average actual evapotranspiration.

Month	ET (mm/day)	
	Abtew	Morton CRAE
Jan	3.39	1.53
Feb	3.87	1.92
Mar	4.05	3.00
Apr	4.26	3.46
May	4.10	3.96
Jun	3.35	4.25
Jul	3.19	4.59
Aug	3.18	5.13
Sep	3.04	5.88
Oct	3.35	4.82
Nov	3.26	3.11
Dec	3.29	1.46

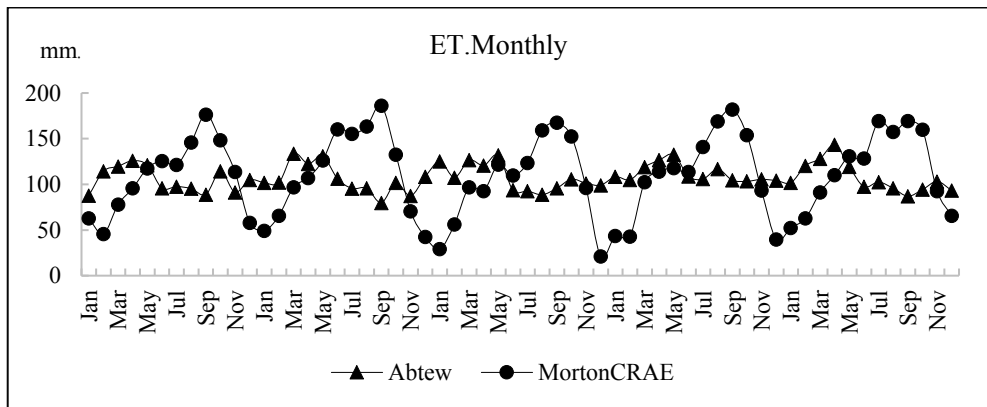


Fig. 1. Comparison monthly average actual evapotranspiration.

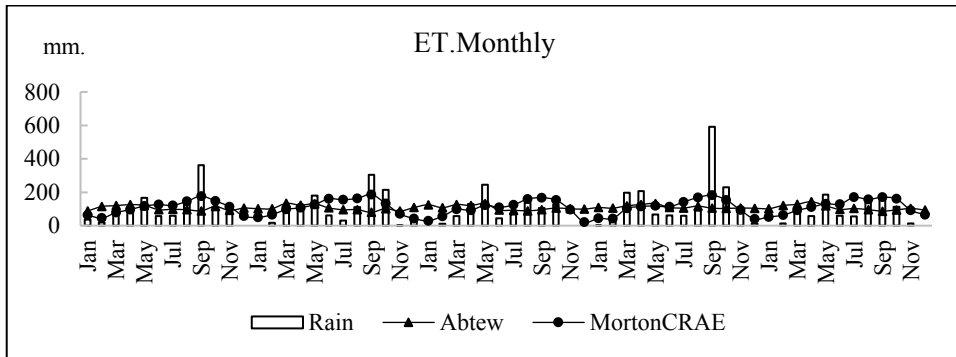


Fig. 2. Comparison of monthly average actual evapotranspiration and rain.

4 Conclusions

Analysis of the evapotranspiration potentials of plants is an analysis to determine the evaporation that occurs in the area. The value of the application in each area will be different due to the changing weather situation in each season or each year. At present, we can see the changing climate in each month of each year. And appears to be more intense and more damaging, especially for crops. Evaluation of the actual evapotranspiration amount of plants by using the study data in Nakhon Ratchasima province with R program (Package 'Evapotranspiration') in the function of the hydrological model of Abteu and Morton CRAE formulation. The results show differences in applying value. Abteu analysis results are high in the dry season and low in the rainy season, which is suitable for irrigation system design. This corresponds to the water needs of plants for growth and evaporation rate. The Morton CRAE method has a high evaporation rate in the rainy season and will be low during the dry season, which is suitable for the drainage system design in the area shows the potential for evaporation. High rainfall shows that the area has the potential to use high water as well. For this research, it will be a guideline for assessing urban flood areas with hydrological model's project.

The writers are grateful to the Department of Agricultural Machinery Engineering, Faculty of Engineering and Architecture, Rajamangala University of Technology Isan to support a scholarship for research.

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