Package 'AquaBEHER'

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Type Package

Title Estimation of rainy season calandar and soil water balance for agriculture

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Author Robel Takele <takelerobel@gmail.com>
Matteo Dell'Acqua <matteo.dellacqua@santannapisa.it>

Maintainer Robel Takele <takelerobel@gmail.com>

Description This R package computes and integrates daily reference evapotranspiration (Eto) into FAO56 water balance model. The AquaBEHER package can estimate daily parameters of crop and soil water balances parameters for agricultural crops. The package can also estimate rainy season calandar (Onset, Cessation and Duration) based on agroclimatic approach.

License GPL (>= 3)

Encoding UTF-8

LazyData true

RoxygenNote 7.2.1

Roxygen list(markdown = TRUE)

Suggests knitr,
rmarkdown,
ggplot2

VignetteBuilder knitr

Depends R (>= 2.10)

R topics documented:

calcEto *Potential Evapotranspiration*

Description

This function calculates Penman-Monteith, Priestley Taylor and Hargreaves-Samani Potential Evapotranspiration using the method described by Allen et al, (1998)

Usage

```
calcEto(data)
```

Arguments

data	a dataframe containing the required climate variables: Columns must contain the following parameters:

```
Lat: latitude of the site in decimal degrees.
Lon: longitude of the site in decimal degrees.
Elev: elevation above sea level in (meters).
Year: year of record "YYYY".
Month: month of record "MM".
Day: day of record "DD".
Rain: daily rainfall in (mm).
Tmax: daily maximum temperature at 2-m height in (°C).
Tmin: daily minimum temperature at 2-m height in (°C).
Eto: daily potential evapotranspiration in (mm).
```

Value

The function generates a list containing the following components:

`ET.Daily`: Daily estimations of reference crop evapotranspiration (mm/day)

`Ra.Daily`: Daily estimations of extraterristrial radiation (MJ/m2/day)

`Slope.Daily`: Daily estimations of slope of vapour pressure curve (kPa/°C)

`ET.type`: Type of the estimation obtained

References

Allen, R.G., L.S. Pereira, D. Raes, and M. Smith. 1998. 'Crop evapotranspiration-Guidelines for Computing Crop Water requirements

See Also

`climateData`, `calcWatBal`, `calcSeasCal`

Examples

```
calcEto(climateData)
```

`calcSeasCal` *Rainy Season Calendar*

Description

This function estimates the rainy season calendar, i.e onset date, cessation data and duration of the rainy season based on Agroclimatic approach. The agroclimatic approach defines the onset of the rainy season as the optimal date that ensures sufficient soil moisture during planting and early growing periods to avoid crop failure after sowing and requires information on rainfall and temperature as well as the soil water balance at daily time scale.

Usage

```
calcSeasCal(
  data,
  onsetWind.start,
  onsetWind.end,
  e_thresh = 0.25,
  AW_thr = 10,
  soilWHC
)
```

Arguments

`data`	an object as returned by calcWatBal or a dataframe having similar parameters.
`onsetWind.start`	Earliest possible start data of the onset window.
`onsetWind.end`	The late possible date for end of the onset window.
`e_thresh`	Threshold value of actual-to-potential evapotranspiration (Ea/Ep); *default value: e_thresh = 0.25*.
`AW_thr`	Threshold value of plant available water (PAW); *default value: AW_thr = 10mm*.
`soilWHC`	Water holding capacity of the soil in (mm).

Details

As per agroclimatic approach, a normal rainy season (growing season) is defined as one when there is an excess of precipitation over potential evapotranspiration (PET). Such a period meets the evapotransiration demands of crops and recharge the moisture of the soil profile (FAO 1977; 1978; 1986). Thus, the rainy season calendar defined accordingly:

Onset

The *onset* of the rainy season will start on the first day after *onsetWind.start*, when the actual-to-potential evapotranspiration ratio *(e_thresh)* is greater than 0.25 and is followed by a 20-day period in which plant available water *(AW_thr)* remains above 10mm.

Cesation

The rainy season will end, *cessation*, on the first day after *onsetWind.end*, when the actual-to-potential evapotranspiration ratio *(e_thresh)* is less than or equal to 0.25 and followed 12 consecutive non-growing days *(AW_thr <= 10mm)*.

Duration

The *duration* of the rainy season is taken as the difference between the Julian day numbers of the determined cessation date and the determined onset date for that season, i.e. the number of days from onset to cessation.

Value

The function generates a data frame containing the following components:

`Year`: year of the rainy season in "YYYY".

`Onset.DOY`: onset date of the rainy season in julian day.

`Cesation.DOY`: cessation date of the rainy season in julian day.

`SeasDur`: durtion of the season in days.

References

FAO, 1977. Crop water requirements. FAO Irrigation and Drainage Paper No. 24, by Doorenbos J and W.O. Pruitt. FAO, Rome, Italy.

FAO 1978. Forestry for Local Community Development Food and Agriculture Organization of the United Nation (FAO), FAO Forestry paper, No 7, Rome.

FAO, 1986. Early Agrometeorological crop yield forecasting. FAO Plant Production and Protection paper No. 73, by M. Frère and G.F. Popov. FAO, Rome, Italy

See Also

`calcEto`, `calcWatBal`

Examples

```
# load example data:
data(climateData)

# estimate daily PET:
PET <- calcEto(climateData)

# Add the estimated PET 'ET.Daily' to a new column in climateData:
climateData$Eto <- PET$ET.Daily

# estimate daily water balance for the soil having 100mm of WHC:
watBal<- calcWatBal(climateData, soilWHC = 100)
```

```
# estimate the rainy season calandar (Onset, Cessation and Duration):

onsetWind.start = "1980-09-01"  # earliest possible start data of the onset window
onsetWind.end = "1981-01-31"   # the late possible date for end of the onset window

seasCal.dF <- calcSeasCal(watBal, onsetWind.start, onsetWind.end,
                          e_thresh = 0.25, AW_thr = 10, soilWHC = 100)

str(seasCal.dF)
```

`calcWatBal` *Soil Water Balance*

Description

Calculates a daily soil water balance computation for the root zone according to methods described in the FAO Irrigation and drainage paper 56 (Doorenbos et al, 1975; Allen et al, 1998)

Usage

```
calcWatBal(data, soilWHC)
```

Arguments

`data`	a dataframe containing the required climate variables: Columns must contain the following parameters:
	`Lat: latitude of the site in decimal degrees.`
	`Lon: longitude of the site in decimal degrees.`
	`Elev: elevation above sea level in (meters).`
	`Year: year of record "YYYY".`
	`Month: month of record "MM".`
	`Day: day of record "DD".`
	`Rain: daily rainfall in (mm).`
	`Tmax: daily maximum temperature at 2-m height in (°C).`
	`Tmin: daily minimum temperature at 2-m height in (°C).`
	`Eto: daily potential evapotranspiration in (mm).`

`soilWHC`	Water holding capacity of the soil in (mm).

Value

The function generates a data frame containing the following components:

`cumRAIN: accumulated rainfall since the begning of the calculation in (mm).`

`DEMAND: aamospheric water demand (total moisture flux to atmospher) in (mm).`

`RUNOFF: surface runoff in (mm).`

`ERATIO: actual-to-potential evapotranspiration ratio.`

`AVAIL: available soil moisture storage in (mm).`

References

Allen, R.G.; Pereira, L.S.; Raes, D.; Smith, M. Crop Evapotranspiration: Guidelines for Computing Crop Water Requirements; FAO Irrigation and Drainage Paper no. 56; FAO: Rome, Italy, 1998; ISBN 92-5-104219-5.

Doorenbos, J. and Pruitt, W.O. 1975. Guidelines for predicting crop water requirements, Irrigation and Drainage Paper 24, Food and Agriculture Organization of the United Nations, Rome, 179 p.

See Also

calcEto, calcSeasCal

Examples

```
# load example data:
data(climateData)

# Estimate daily PET:
PET <- calcEto(climateData)

# Add the estimated PET 'ET.Daily' to a new column in climateData:
climateData$Eto <- PET$ET.Daily

# Estimate daily water balance for the soil having 100mm of WHC:
watBal<- calcWatBal(climateData, soilWHC = 100)

# Visualizing water balance parameters for 1982/83 season
watBal.82T83 <- watBal[watBal$Year %in% c(1982, 1983),]
date.vec <- as.Date.character(paste0(watBal.82T83$Year, "-",
                                     watBal.82T83$Month, "-", watBal.82T83$Day))

 plot(y = watBal.82T83$Rain, x = date.vec, ty="l", col="blue", xlab="", ylab=" Water (mm)",
      main="Daily Water Balance Parameters")
 lines(y = watBal.82T83$Eto, x = date.vec, col="red", lwd = 3)
 lines(y = watBal.82T83$AVAIL, x = date.vec, col="black", lwd = 1, lty = 2)

  legend("bottomright",c("Rain","Eto","Available Moisture"),
        horiz=FALSE, bty='n', cex=1.2,lty=c(1,1,2),lwd=c(2,2,2), inset=c(0,1),
        xpd=TRUE, col=c("blue","red","black"))
```

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climateData *A dataframe containing raw climate data*

Description

The R data object was obtained from Instituto Nacional de Meteorologia (INAM). This example data set contains the raw climate data including the variables required for calculating evapotranspiration and soil water balance over the period between 1/1/1980 and 12/31/1984 at a weather station located in Nampula province of Mozambique.

Usage

```
data(climateData)
```

Format

A data frame with 1827 rows and 11 variables:

- `WMO_Code`: *World Meteorological Organization (WMO) station code.*
- `Station_Name`: *name of the weather station.*
- `Lat`: *latitude of the site in decimal degrees.*
- `Lon`: *longitude of the site in decimal degrees.*
- `Elev`: *elevation above sea level in (meters).*
- `Year`: *year of record "YYYY".*
- `Month`: *month of record "MM".*
- `Day`: *day of record "DD".*
- `Rain`: *daily rainfall in (mm).*
- `Tmax`: *daily maximum temperature at 2-m height in (°C).*
- `Tmin`: *daily minimum temperature at 2-m height in (°C).*

Source

INAM - Instituto Nacional de Meteorologia, Mozambique https://www.inam.gov.mz/

See Also

`calcEto` for a daily estimation of potential evapotranspiration.

Examples

```
# load example data:
data(climateData)

# Get the structure of the data frame:
str(climateData)

# Get the head of the data frame:
head(climateData)
```

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