

# Package ‘cropDemand’

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**Type** Package

**Title** Spatial Crop Water Demand for Brazil

**Version** 1.0.3

**Description** Estimation of crop water demand can be processed via this package. As example, the data from 'TerraClimate' dataset (<https://www.climatologylab.org/terraclimate.html>) calibrated with automatic weather stations of National Meteorological Institute of Brazil is available in a coarse spatial resolution to do the crop water demand. However, the user have also the option to download the variables directly from 'TerraClimate' repository with the `download.terraclimate` function and access the original 'TerraClimate' products. If the user believes that is necessary calibrate the variables, there is another function to do it. Lastly, the estimation of the crop water demand present in this package can be run for all the Brazilian territory with 'TerraClimate' dataset.

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**Encoding** UTF-8

**Language** en-US

**Depends** R (>= 3.2.0),

**Imports** dplyr(>= 0.3.0.1), ggplot2(>= 3.3.2), terra, sf, tidyr, ncdf4

**BugReports** <https://github.com/FilgueirasR/cropDemand/issues>

**RoxygenNote** 7.1.1

**NeedsCompilation** no

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download\_terraclimate *Download of reference evapotranspiration (eto) and rainfall (ppt) from 'TerraClimate'*

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### Description

This function will download the eto and ppt and will load a SpatRaster according to the the region of interest (Region and sub\_region).

### Usage

```
download_terraclimate(dir_out, variable, years, region, sub_region)
```

### Arguments

dir_out	Directory where you want to save the raster images that you are going to download.
variable	Variable to download. This function will download the eto or ppt (SpatRaster).
years	The period in years that the function should download images.
region	Use the "brazil" shapefile to extract the SpatRaster (variable) for one state (Brazilian state), or use the "biomes_brazil" to extract the SpatRaster (variable) for one biome of Brazil.
sub_region	You have two options in this section, if you choose the brazil (in region parameter) you need to choose the Brazilian states, but if you choose the biomes_brazil (in region parameter) you must choose one of Brazilian biomes.

### Value

Download for the region of interest the ppt (Rainfall) or eto (reference evapotranspiration) SpatRaster

## References

The images used in this package can be found in the paper: Abatzoglou, J.T., S.Z. Dobrowski, S.A. Parks, K.C. Hegewisch, 2018, Terraclimate, a high-resolution global dataset of monthly climate and climatic water balance from 1958-2015, Scientific Data.

## Examples

```
## Not run:

### Downloading eto based on Brazil states.
see_brazil_states()

img<-download_terraclimate(variable = "eto",
                           years = c(2018:2019),
                           region = "brazil",
                           sub_region = 13)

### Downloading the ppt based on Brazil biomes.
see_brazil_biomes()

img<-download_terraclimate(variable = "ppt",
                           years = c(2018:2019),
                           region = "biomes_brazil",
                           sub_region = 6)

## End(Not run)
```

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eto\_calibration

*Calibration of reference evapotranspiration (eto) of 'TerraClimate'*

---

## Description

This function will calibrate the reference evapotranspiration (eto) from TerraClimate dataset based in the relationship with observed weather stations data.

## Usage

```
eto_calibration(slope, intercept, eto_stack)
```

## Arguments

slope	the slope of the linear regression (numeric).
intercept	the intercept of the linear regression (numeric).
eto_stack	stack of eto.

## Value

Returns a SpatRaster of eto calibrated.

**Examples**

```
## Not run:
eto_cal<- eto_calibration(slope = 0.930073,
                        intercept = 22.399986, eto_stack = etp);

## End(Not run)
```

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loadROI	<i>Load image data to do crop water demand</i>
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**Description**

This function will load the evapotranspiration and rainfall data for the region of interest (ROI).

**Usage**

```
loadROI(variable, region, sub_region)
```

**Arguments**

variable	Stack of evapotranspiration or rainfall (SpatRaster).
region	Use the "brazil" shp file to extract the SpatRaster (variable) for one state (Brazilian state), or use the "biomes_brazil" to extract the SpatRaster (variable) for one biome of Brazil.
sub_region	You have two options in this section, if you choose the brazil (in region parameter) you need to choose the Brazilian states, but if you choose the biomes-brazil (in region parameter) you must choose one of Brazilian biomes.

**Value**

Load the reference evapotranspiration (eto) or rainfall (ppt) SpatRaster

**References**

The images used in this package can be found in the paper: Abatzoglou, J.T., S.Z. Dobrowski, S.A. Parks, K.C. Hegewisch, 2018, Terraclimate, a high-resolution global dataset of monthly climate and climatic water balance from 1958-2015, Scientific Data.

**Examples**

```
## Not run:
#For Brazilian states

see_brazil_states()

image_etp<-loadROI(variable = "eto", region = "brazil",
                  sub_region = 13) # sub_regions 1:27
```

```

image_rainfall<-loadROI(variable = "ppt",
                        region = "brazil", sub_region = 13)

#For Brazilian Biomes:

see_brazil_biomes()

image_tmin<- loadROI(variable = "eto", region = "biomes_brazil",
                    sub_region = 2)# sub regions: 1:6 (biomes)

## End(Not run)

```

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monthly_stack	<i>Function to calculate the mean monthly rainfall/reference evapotranspiration to generate the crop water demand</i>
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### Description

This function will calculate the mean monthly air temperature based on the period of time selected (start\_date and end\_date).

### Usage

```
monthly_stack(stack, start_date, end_date)
```

### Arguments

stack	Stack of mean rainfall/reference evapotranspiration SpatRaster
start_date	Date that start the investigation, should be in the following format (2000-01-01 /Year-Month-Day)
end_date	Date that end the investigation, should be in the following format (2017-12-31 /Year-Month-Day)

### Value

Returns a SpatRaster with a monthly mean air temperature from a period of time

### Examples

```

## Not run:
start_date <- c('2000-01-01')
end_date <- c('2017-12-01')
monthly_rainfall <- monthly_stack(stack = rainfall_stack,
                                start_date = start_date, end_date = end_date)

## End(Not run)

```

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plot_AWC	<i>Function to plot the percentage of Available Water Capacity (AWC)</i>
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**Description**

This function will plot the monthly AWC

**Usage**

```
plot_AWC(AWC_stack)
```

**Arguments**

AWC\_stack      A SpatRaster generated in WaterDemand function

**Value**

Returns a plot (gg file) of monthly percentage of AWC

**Examples**

```
## Not run:  
plot_AWC(AWC_stack)  
  
## End(Not run)
```

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ppt_calibration	<i>Calibration of rainfall (ppt) of 'TerraClimate'</i>
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---

**Description**

This function will calibrate the rainfall (ppt) from TerraClimate dataset based in the relationship with observed weather stations data.

**Usage**

```
ppt_calibration(slope, intercept, ppt_stack)
```

**Arguments**

slope            the slope of the linear regression (numeric).  
intercept        the intercept of the linear regression (numeric).  
ppt\_stack        stack of ppt.

**Value**

Returns a SpatRaster of ppt calibrated.

**Examples**

```
## Not run:  
  
ppt_cal<- ppt_calibration(slope = 0.7000972,  
                          intercept = 23.753785, ppt_stack = ppt);  
  
## End(Not run)
```

---

see_brazil_biomes	<i>Function to see the Brazilian biomes available tp use in down-load.terraclimate and loadROI function</i>
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**Description**

This function will show the biomes available in the package and how we can call each biome polygon.

**Usage**

```
see_brazil_biomes()
```

**Value**

The biomes information available to run the cropDemand package.

**Examples**

```
## Not run:  
see_brazil_biomes()  
  
## End(Not run)
```

---

see_brazil_states	<i>Function to see the Brazilian states available to use in down-load.terraclimate and loadROI function</i>
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**Description**

This function will show the Brazilian state available in the package and how we can call each state polygon.

**Usage**

```
see_brazil_states()
```

**Value**

The Brazilian state information available in the package to run the cropDemand package.

**Examples**

```
## Not run:
see_brazil_states()

## End(Not run)
```

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waterDemand	<i>Function to generate the water demand based in available water capacity of the soil</i>
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**Description**

This function will calculate the water balance parameters based in the available water capacity informed (AWC). The output water balance parameters for this function are:

1. ARM - storage;
2. ALT - alteration;
3. ETR - actual evapotranspiration;
4. DEF - deficit;
5. EXC - excess;
6. REP - replacement;
7. RET - withdrawal;
8. AWC\_arm - percentage of storage compared to AWC;

**Usage**

```
waterDemand(out_dir, ppt_stack, eto_stack, AWC)
```

**Arguments**

out_dir	output directory where you want to save the variables
ppt_stack	Stack of mean rainfall Rasterstack calculated in monthly_stack function
eto_stack	Stack of mean evapotranspiration Rasterstack calculated in monthly_stack function
AWC	The available water capacity (AWC) that the function will use in the calculations. The AWC value must be chosen according to the crop (root system depth) you want to obtain the water balance.

**Value**

Returns multiple Rasterstack object as output (explained in description).

**Examples**

```
## Not run:  
cwd<- waterDemand(out_dir = "G:/My computer/test/CropWaterDemand",  
                  ppt_stack = rainfall_image, eto_stack = eto_image, AWC = 100)  
  
## End(Not run)
```

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