Package 'MTTfireCAL'

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Type Package

Title Minimum Travel Time (MTT) fire spread semi-automatic calibrator

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Description Minimum Travel Time (MTT) fire spread semi-automatic calibrator.

License What license is it under?

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stringr,
zoo,
lwgeom,
tibble,
dplyr,
ggplot2,
ggspatial,
rnaturalearth,
rnaturalearthdata,
RColorBrewer,
tidyquant,
factoextra,
scatterplot3d,
car,
mclust,
ggpubr,

officer,
flextable,
magrittr,
abind

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`build_report` *Characterizes the fire regime and meteorology*

Description

Creates files with meteorological characterization of the study area during fire events (csv and fms files); and a word file with the characterization of the fire regime.

Usage

```
build_report(
  study.area,
  my.fires,
  my.dated.fires,
  meteo.data,
  active.period,
  user.period,
  meteo.aggregation,
  min.size,
  min.overlap,
  output.folder,
  fire.aggregation,
  fire.size.intervals,
  manual.dur,
  create.clusters
)
```

Arguments

`study.area`	Shapefile with the limits of the study area (polygon). Must not contain more than one polygon.
`my.fires`	Polygon shapefile containing the fire perimeters (dated or not). This shapefile will be used to characterize the fire regime and to propose the durations to use in the MTT simulation. Must contain a field "Year".

`my.dated.fires` Polygon shapefile containing the dated fire perimeters. Same as the dated fire perimeters used in function get.fire.weather

`meteo.data` A csv file with the meteorological variables in the days with fire events. This file is generated by the function get.fire.weather, and stored as fire_weather_study_area.csv. The user might use a different file, as long as maintaining the same structure.

`active.period` The most common active period of fire spread. Will be used to select the interval of meteorological values to be used in the creation of clusters or percentiles.

`user.period` Optional. Numerical vector with the hours to be used in the fire weather characterization.

`meteo.aggregation`
How hourly data should be combined into daily data. Possible methods include: mean (computes the mean of each variable for the active.period), max.min (computes the maximum value of temperature and wind speed and the minimum relative humidity for the active.period), none (does not combine hourly data into daily data and uses all the data in the creation of clusters or percentiles).

`min.size` Numerical. Minimum fire size to be considered in the analysis. Useful to subset the fire sample

`min.overlap` Numerical. Minimal overlap (as percentage) between the fire perimeters and the study area to consider the fire perimeter in the analysis. Must range between 0 and 100.

`output.folder` Path to the folder where the outputs should be saved.

`fire.aggregation`
How the meteorology of different points inside the same fire perimeter should be combined. Possible methods include: WS (wind speed; the point falling inside the fire perimeter with highest wind speed is kept and the other ignored), none (uses all the points falling inside the fire perimeter).

`fire.size.intervals`
Numeric vector with the fire size classes to be considered in the characterization of the study area.

`manual.dur` Optional. Numeric vector with the lower limits of each fire size class to be considered as a duration interval. To be used in the MTT calibration process (Run.fcontmtt function)

`create.clusters`
Logical. True returns clusters generated by using kmeans and model-based clustering. False returns percentiles of the meteorological data.

Value

Returns fuel moisture file based on clustering or percentiles, a csv file with the meteorological values per clustering method, a csv file with a summary of meteorology per fire event, and a csv file with the fire size for the fires recorded in the study area in the period analysed.

Examples

```
## Not run: build_report(study.area="C:/user/study_area.shp",
my.fires="C:/user/my_fires.shp",my.dated.fires="C:/user/my_dated_fires.shp",
meteo.data="fire_weather_study_area.csv",active.period="energy",
user.period=c(14,15,16),meteo.aggregation="max.min",
min.size=100,min.overlap=50,fire.aggregation="WS",
fire.size.intervals=c(100,250,500,750,1000,2500,5000,10000),
create.clusters=TRUE,output.folder="C:/user/results")
```

```
## End(Not run)
```

`check_BP_nxburned` *Compares the estimated burn probability with the historical number of times burned.*

Description

Combines and calculates the pearson correlation between the estimated burn probability that result from multiple duration combinations and the historical number of times burned.

Usage

```
check_BP_nxburned(
  Folder.Outputs,
  freq.scenario,
  choose.combos,
  combos.file,
  obs.nxburned,
  export.plots
)
```

Arguments

`Folder.Outputs`	Path to the folder containing the outputs of the FConstMTT runs.
`freq.scenario`	Text file (csv) with the relative frequency of each meteorological and fuel map scenario used. If the function Gen_ign was used in the process, then the file to be used here should be "clusters_freqs_final.csv", which is located in the ignition folder.
`choose.combos`	A text file (csv) with the numeric identification of the different combinations. If check_fire_size was run, then this file was stored as "rmse_combos.csv".
`combos.file`	Numerical vector. Specify the combinations to be tested. The numeric identification of the combinations is located in the combos.file. In alternative, use "all" to use all duration combinations.
`obs.nxburned`	Raster file with the historical number of times burned. This raster must have the same spatial resolution and alignment that the simulated burn probability rasters.
`export.plots`	Binary. If 1, then a boxplot showing the correlation between the estimated burn probability and the number of times burned is saved. If 0, no plot is saved.

Value

Returns a raster file with the simulated burn probability and a text file (csv) showing the pearson correlation between the simulated burn probability for each combination and the historical number of times burned. Optionally, it can also return a boxplot showing the same correlation.

Examples

```
## Not run: check_BP_nxburned(Folder.Outputs="C:/user/fconstmtt/Outputs",
freq.scenario="C:/user/results/ignitions/clusters_freqs_final.csv",
choose.combos=c(1,2),combos.file="C:/user/fconstmtt/Outputs/rmse_combos.csv",
obs.nxburned="C:/user/number_of_times_burned.tif",
export.plots=1)
## End(Not run)
```

`check_fire_size` *Compares the simulated fire size distribution with the historical fire size distribution*

Description

Combines and calculates the RMSE and pearson correlation between all the durations simulated and the historical fire size distribution.

Usage

```
check_fire_size(
  Folder.Outputs,
  intervals,
  all.dist,
  hist.fire.sizes,
  freqs.durclass
)
```

Arguments

`Folder.Outputs`	Path to the folder containing the outputs of the FConstMTT runs.
`intervals`	Numerical vector with the intervals of fire size to be considered in the comparison between simulated and the historical fire size distribution.
`all.dist`	Logical. If true, then all the fire size distribution is used to calculate the RMSE and the correlation. If false, then the fire size distribution will only be considered starting from the first numeric value identified in intervals.
`hist.fire.sizes`	Text file (csv) containing the historical fire size. If the function get_fire_weather was used in the process, then the file to be used should be "summary fire size.csv".
`freqs.durclass`	Text file (csv) with the relative frequency of each meteorological and fuel map scenario used. If the function Gen_ign was used in the process, then the file to be used here should be "clusters_freqs_final.csv", which is located in the ignition folder.

Value

Returns figures showing the historical and simulated fire size distribution for all the combinations. Also saves a csv file containing the RMSE and person correlation of each combination of durations and the historical fire size.

Examples

```
## Not run: check_fire_size(Folder.Outputs="C:/user/fconstmtt/Outputs",
intervals=c(100,250,500,750,1000,2500,5000,10000),all.dist=FALSE,
hist.fire.sizes="C:/user/summary fire size.csv",
freqs.durclass="C:/user/results/ignitions/clusters_freqs_final.csv")
## End(Not run)
```

`fire_weather_nc` *Get meteorological variables from an existing netcdf file*

Description

Get meteorological variables from an existing netcdf file and stores it in a csv file.

Usage

```
fire_weather_nc(study.area, my.fires, nc.folder, output.folder)
```

Arguments

`study.area`	Shapefile with the limits of the study area (polygon). Must not contain more than one polygon.
`my.fires`	Polygon shapefile containing the dated fire perimeters. The shapefile must contain a field with a unique id per fire perimeter (ID), a field with the burned area per perimeter in hectares (Area_ha), a field with the date of start of the fire (Date_ini) and the end of the fire (Date_end). The fields Date_ini and Date_end must follow the format yyyy-mm-dd.
`nc.folder`	Path to the folder with the netcdf file.
`output.folder`	Path to the folder where the outputs should be saved.

Value

Returns a csv file with the hourly meteorological data per fire perimeter in the study area (fire_weather_study_area.csv)

Examples

```
## Not run: fire_weather_nc(study.area="C:/user/study_area.shp",
my.fires="C:/user/my_fires.shp",nc.folder="C:/user/netdcf_file.nc",
output.folder="C:/user/results")
## End(Not run)
```

Gen_ign *Generates ignitions in the study area.*

Description

Generates ignitions in the study area that either follow a surface of probability of ignition (raster file) or are randomly allocated.

Usage

```
Gen_ign(
  ign.raster,
  IgnitionData,
  fuelmap,
  nIgnitions,
  unburnable,
  LandCover.yr,
  LandCover.wgt,
  shapeOut,
  allow.zero,
  random.ignitions,
  output.folder
)
```

Arguments

ign.raster	Raster file with the probability of ignition.
IgnitionData	Text file (csv) with the relative frequency of each meteorological cluster (or percentile) and duration to be simulated. If the function build_report was used in the process, then the file to be used should is stored in the folder final_freqs.
fuelmap	Fuel map raster file. In alternative to using only one fuel map, the user might specify multiple fuel maps as a vector of characters.
nIgnitions	Numeric. Total number of ignitions to be generated.
unburnable	Numeric. Value of the fuel model(s) considered unburnable. Ignitions are prevented from being sampled in the fuel model(s) indicated.
LandCover.yr	Numeric. Value (or vector of values) of the years of the fuel maps given as input in fuelmap.
LandCover.wgt	Numeric. Value (or vector of values) of the weights of each fuel map in the fuelmap and LandCover.yr. The sum of the values must be 1.
shapeOut	Binary. If 1, then a point shapefile is generated. If 0, only a text file with the coordinates of the ignitions is generated.
allow.zero	Logical. If true, then a 0 percent probability of ignition is allowed in the raster file ign.raster. If false, then a minimum probability corresponding to the 5th percentile of the ign.raster is set. Default is false.
random.ignitions	Logical. If true, then ignitions are generated randomly across the study area (excluding in the fuel model identified as unburnable). Default is false.
output.folder	Path to the folder where the outputs should be saved.

Value

Returns text files with the coordinates of the ignitions in the correct format to be used in FConstMTT. One text file is generated by a combination of meteorological cluster, wind direction and duration class. A point shapefile per combination can also be generated.

Examples

```
## Not run: Gen_ign(ign.raster="C:/user/ignition.tif",
IgnitionData="C:/user/results/final_freqs/kmean_3_clusters_final_freqs.csv",
fuelmap=c("C:/user/fuelmap_2000","C:/user/fuelmap_2010"),nIgnitions=5000,
unburnable=c(98),LandCover.yr=c(2000,2010),LandCover.wgt=c(0.4,0.6),
shapeOut=1,allow.zero=FALSE,random.ignitions=FALSE,
output.folder="C:/user/results")
## End(Not run)
```

---

get_fire_weather *Downloads ERA5-Land reanalysis data and stores it in a csv file*

Description

Downloads ERA5-Land reanalysis data and stores it in a csv file

Usage

```
get_fire_weather(
  study.area,
  my.fires,
  output.folder,
  utc.zone,
  wf_user,
  wf_key
)
```

Arguments

study.area	Shapefile with the limits of the study area (polygon). Must not contain more than one polygon.
my.fires	Polygon shapefile containing the dated fire perimeters. The shapefile must contain a field with a unique id per fire perimeter (ID), a field with the burned area per perimeter in hectares (Area_ha), a field with the date of start of the fire (Date_ini) and the end of the fire (Date_end). The fields Date_ini and Date_end must follow the format yyyy-mm-dd.
output.folder	Path to the folder where the outputs should be saved.
utc.zone	Numeric. Represents the UTC time zone in the study area. Should be set to the time zone during the fire season (i.e. the user should consider the daylight saving time). E.g. for Portugal, the utc.zone should be set to +1.
wf_user	Personal UID that identifies the user in the Climate Change Service (CDS). Can be retrieved from the user profile page after logging in at https://cds.climate.copernicus.eu/user
wf_key	Personal API Key that identifies the user in the Climate Change Service (CDS). Can be retrieved from the user profile page after logging in at https://cds.climate.copernicus.eu/user

Value

Returns a raw netdcf file with all the hourly meteorological variables of temperature, relative humidity, wind speed and direction (same as simply using the wf_request function from the ecmwfr package; the request is stored at https://cds.climate.copernicus.eu/cdsapp#!/yourrequests). Also returns a csv file with the hourly meteorological data per fire perimeter in the study area (fire_weather_study_area.csv)

Examples

```
## Not run: get_fire_weather(study.area="C:/user/study_area.shp", my.fires="C:/user/my_fires.shp",
utc.zone=+1,wf_user="12345",wf_key="123456ab-12a3-1234-1234-123ab4567891",
output.folder="C:/user/results")
## End(Not run)
```

---

run_fconstmtt *Create the inputs and runs FConstMTT from batch files*

Description

Uses the files generated by the functions build_report and Gen_ign to generate the input and batch files and to run FConstMTT.

Usage

```
run_fconstmtt(
  Folder,
  landscape,
  CrownFireMethod,
  customfmd,
  FmsFolder,
  Resolution,
  GridDistanceUnits,
  MeteoFile,
  Duration.1,
  Duration.2,
  Duration.3,
  Duration.4,
  Duration.5,
  WS_unit,
  FireListFile,
  SpotProbability,
  output.folder,
  OutputFirePerims,
  MetricFLP,
  Run.fconstmtt
)
```

Arguments

Folder	Path to the folder containing the bin folder with the FContMTT executable. This will also be the folder where the input and the batch files will be saved.

`landscape` Path to the folder contained the landscape file(s) to be used (either .tif or .lcp)

`CrownFireMethod`
Numerical. Either 0 for the Finney's method, or 1 for use of Scott and Rheinhardt's method.

`customfmd` File containing the characterization of custom fuel models (.fmd file).

`FmsFolder` Path to the folder containing the fms file(s) to be use in the simulation.

`Resolution` Numeric. Represents the desired resolution of calculations.

`GridDistanceUnits`
Numeric. Sets grid distance units, where 0 is for meters and 1 is for feet.

`MeteoFile` Text file containing the meteorological characterization of the clusters or percentiles to be used in the simulation.

`Duration.1` Vector of values that define the interval of duration values to be tested in the first duration class. The vector must contain three values: c(from, to, by).

`Duration.2` Optional. vector of values that define the interval of duration values to be tested in the second duration class. The vector must contain three values: c(from, to, by).

`Duration.3` Optional. vector of values that define the interval of duration values to be tested in the third duration class. The vector must contain three values: c(from, to, by).

`Duration.4` Optional. vector of values that define the interval of duration values to be tested in the fourth duration class. The vector must contain three values: c(from, to, by).

`Duration.5` Optional. vector of values that define the interval of duration values to be tested in the fifth duration class. The vector must contain three values: c(from, to, by).

`WS_unit` Either kmh or mph.

`FireListFile` Path to the folder containing the ignitions to be used.

`SpotProbability`
Numerical. Value to be used in the spot probability during the FConstMTT simulations.

`output.folder` Path to the folder where the outputs should be saved.

`OutputFirePerims`
Binary. If 1, then the simulated fire perimeters are stored. If 0, then the simulated fire perimeters are not stored.

`MetricFLP` If 1, then the outputs of flame length probability (FLP file) are stored in meters. If 0, then the FLP files are stored in feet.

`Run.fconstmtt` Binary. If 1, then FConstMTT will automatically start running after creating the required files. If 0, then the .input and batch files are created but FConstMTT does not start running.

Value

Returns the input and batch files required to run FConstMTT for all the combinations to be tested. Optionally, FConstMTT might be run from R after the creation of the required files.

Examples

```
## Not run: run_fconstmtt(Folder="C:/user",landscape="C:/user/landscape_files",
CrownFireMethod=1,customfmd="C/user/my_fmd.fmd",
FmsFolder="C:/user/results/FMS_files/kmeans_3_clusters",
```

```
Resolution=100,GridDistanceUnits=0,
MeteoFile="C:/user/results/clusters_meteo/kmeans_3_clusters.csv",
Duration.1=c(min,max,by),
Duration.2=c(min,max,by),
Duration.3=c(min,max,by),
Duration.4=c(min,max,by),
Duration.5=c(min,max,by),
WS_unit="kmh",
FireListFile="C:/user/results/ignitions",SpotProbability=0.05,
output.folder="C:/user/fconstmtt/Outputs",
OutputFirePerims=1,MetricFLP=0,
Run.fconstmtt=1)
## End(Not run)
```

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