Package 'cffdrs.core'

February 1, 2022

Type Package

Title Canadian Forest Fire Danger Rating System

Version 1.0.0

Date 2021-11-17

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Depends R(>= 3.2.2)

Description This project provides a group of new functions to calculate the outputs of the two main components of the Canadian Forest Fire Danger Rating System (CFFDRS) Van Wagner and Pickett (1985) <https://cfs.nrcan.gc.ca/publications?id=19973>) at various time scales: the Fire Weather Index (FWI) System Wan Wagner (1985) <https://cfs.nrcan.gc.ca/publications?id=19927> and the Fire Behaviour Prediction (FBP) System Forestry Canada Fire Danger Group (1992) <http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/10068.pdf>.

License GPL-2

URL https://r-forge.r-project.org/projects/cffdrs/

BugReports https://r-forge.r-project.org/tracker/?func=browse&group_id=1970&atid=5372

Encoding UTF-8

LazyData true

Suggests testthat (>= 3.0.0)

Config/testthat/edition 3

RoxygenNote 7.1.2

R topics documented:

`cffdrs.core-package` *Canadian Forest Fire Danger Rating System*

Description

The cffdrs.core package allows R users to calculate the outputs of the two main components of the Canadian Forest Fire Danger Rating System (CFFDRS; http://cwfis.cfs.nrcan.gc.ca/background/summary/fdr): the Fire Weather Index (FWI) System (http://cwfis.cfs.nrcan.gc.ca/background/summary/fwi) and the Fire Behaviour Prediction (FBP) System (http://cwfis.cfs.nrcan.gc.ca/background/summary/fbp) along with additional methods created and used Canadian fire modelling. These systems are widely used internationally to assess fire danger (FWI System) and quantify fire behavior (FBP System).

Details

The FWI System (Van Wagner 1987) is based on the moisture content and the effect of wind of three classes of forest fuels on fire behavior. It consists of six components: three fuel moisture codes (Fire Fuel Moisture Code, Duff Moisture Code, Drought Code), and three fire behavior indexes representing rate of spread (Initial Spread Index), fuel consumption (Buildup Index), and fire intensity (Fire Weather Index). The FWI System outputs are determined from daily noon weather observations: temperature, relative humidity, wind speed, and 24-hour rainfall.

The FBP System (Forestry Canada Fire Danger Group 1992; Hirsch 1996) provides a set of primary and secondary measures of fire behavior. The primary outputs consist of estimates of fire spread rate, fuel consumption, fire intensity, and fire description (i.e., surface, intermittent, or crown fire).

The secondary outputs, which are not used nearly as often, give estimates of fire area, perimeter, perimeter growth rate, and flank and back fire behavior based on a simple elliptical fire growth model. Unlike the FWI System, which is weather based, the FBP System also requires information on vegetation (hereafter, fuel types) and slope (if any) to calculate its outputs. Sixteen fuel types are included in the FBP System, covering mainly major vegetation types in Canada.

Package:	cffdrs.core
Type:	Package
Version:	1.8.16
Date:	2020-05-26
License:	GPL-2

Author(s)

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References

1. Van Wagner, C.E. and T.L. Pickett. 1985. Equations and FORTRAN program for the Canadian Forest Fire Weather Index System. Can. For. Serv., Ottawa, Ont. For. Tech. Rep. 33. 18 p.

2. Van Wagner, C.E. 1987. Development and structure of the Canadian forest fire weather index system. Forest Technology Report 35. (Canadian Forestry Service: Ottawa).

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4. Hirsch K.G. 1996. Canadian Forest Fire Behavior Prediction (FBP) System: user's guide. Nat. Resour. Can., Can. For. Serv., Northwest Reg., North. For. Cent., Edmonton, Alberta. Spec. Rep. 7. 122p.

5. Forestry Canada Fire Danger Group. 1992. Development and structure of the Canadian Forest Fire Behavior Prediction System. Forestry Canada, Ottawa, Ontario Information Report ST-X-3. 63 p. http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/10068.pdf

6. Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p. http://publications.gc.ca/collections/collection_2010/nrcan/Fo123-2-10-2009-eng.pdf

7. Tymstra, C., Bryce, R.W., Wotton, B.M., Armitage, O.B. 2009. Development and structure of Prometheus: the Canadian wildland fire growth simulation Model. Nat. Resour. Can., Can. For. Serv., North. For. Cent., Edmonton, AB. Inf. Rep. NOR-X-417.

See Also

fbp, fireSeason, fwi, gfmc, hffmc, ShelteredDuffMoistureCode, wDC

BackRateOfSpread *Back Fire Rate of Spread Calculator*

Description

Calculate the Back Fire Spread Rate. All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992).

Usage

```
BackRateOfSpread(FUELTYPE, FFMC, BUI, WSV, FMC, SFC, PC, PDF, CC, CBH)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
FFMC	Fine Fuel Moisture Code
BUI	Buildup Index
WSV	Wind Speed Vector
FMC	Foliar Moisture Content
SFC	Surface Fuel Consumption
PC	Percent Conifer
PDF	Percent Dead Balsam Fir
CC	Degree of Curing (just "C" in FCFDG 1992)
CBH	Crown Base Height

Value

BROS: Back Fire Rate of Spread

References

https://cfs.nrcan.gc.ca/publications/download-pdf/10068 Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

BuildupEffect *Build Up Effect Calculator*

Description

Computes the Buildup Effect on Fire Spread Rate. All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992).

Usage

```
BuildupEffect(FUELTYPE, BUI)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
BUI	The Buildup Index value

Value

BE: Build up effect

References

https://cfs.nrcan.gc.ca/publications/download-pdf/10068 Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

BuildupIndex *Build Up Index Calculator*

Description

Buildup Index Calculation. All code is based on a C code library that was written by Canadian Forest Service Employees, which was originally based on the Fortran code listed in the reference below. All equations in this code refer to that document. Equations and FORTRAN program for the Canadian Forest Fire Weather Index System. 1985. Van Wagner, C.E.; Pickett, T.L. Canadian Forestry Service, Petawawa National Forestry Institute, Chalk River, Ontario. Forestry Technical Report 33. 18 p.

Usage

```
BuildupIndex(dmc, dc)
```

Arguments

dmc	Duff Moisture Code
dc	Drought Code

Value

A single Build Up Index value

References

http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/19927.pdf Development and structure of the Canadian Forest Fire Weather Index System. 1987. Van Wagner, C.E. Canadian Forestry Service, Headquarters, Ottawa. Forestry Technical Report 35. 35 p.

`CriticalSurfaceIntensity`

Critical Surface Intensity Calculator

Description

Calculate Critical surface intensity (CSI).

Usage

```
CriticalSurfaceIntensity(FUELTYPE, FMC, CBH)
```

Arguments

`FMC`	Foliar Moisture Content
`CBH`	Crown Base Height

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

CSI

References

https://cfs.nrcan.gc.ca/publications/download-pdf/10068 Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

`CriticalSurfaceRateOfSpread`

Critical Surface Rate of Spread Calculator

Description

Calculate Critical Surface fire rate of spread (RSO). The value of each of these equations can be returned to the calling function without unecessary additional calculations.

Usage

```
CriticalSurfaceRateOfSpread(CSI, SFC)
```

Arguments

`CSI`	Critical Surface Intensity
`SFC`	Surface Fuel Consumption

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

RSO

References

https://cfs.nrcan.gc.ca/publications/download-pdf/10068 Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

CrownFractionBurned *Crown Fraction Burned Calculator*

Description

Calculate Calculate Crown Fraction Burned.

Usage

```
CrownFractionBurned(FUELTYPE, ROS, RSO)
```

Arguments

ROS	Rate of Spread
RSO	Critical Surface Rate of Spread

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

CFB

References

https://cfs.nrcan.gc.ca/publications/download-pdf/10068 Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

CrownFuelConsumption *Crown Fuel Consumption calculation*

Description

Computes the Crown Fuel Consumption by Fuel Type. All variables names are laid out in the same manner as FCFDG (1992) or Wotton et. al (2009)

Usage

```
CrownFuelConsumption(FUELTYPE, CFL, CFB, PC, PDF)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
CFL	Crown Fuel Load (kg/m^2)
CFB	Crown Fraction Burned (0-1)
PC	Percent Conifer (%)
PDF	Percent Dead Balsam Fir (%)

Details

Forestry Canada Fire Danger Group (FCFDG) (1992). "Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p.

Value

CFC Crown Fuel Consumption (kg/m^2)

CrownRateOfSpreadC6 *C-6 Crown Fire Spread Calculator*

Description

Calculate crown rate of spread (RSC).

Usage

```
CrownRateOfSpreadC6(ISI, FMC)
```

Arguments

ISI	Initial Spread Index

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

RSC

References

https://cfs.nrcan.gc.ca/publications/download-pdf/10068 Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

DistanceAtTime *Distance at time t calculator*

Description

Calculate the Head fire spread distance at time t. In the documentation this variable is just "D".

Usage

```
DistanceAtTime(FUELTYPE, ROSeq, HR, CFB)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
ROSeq	The predicted equilibrium rate of spread (m/min)
HR	The elapsed time (min)
CFB	Crown Fraction Burned

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

DISTt - Head fire spread distance at time t

DroughtCode *Drought Code Calculator*

Description

Drought Code Calculation. All code is based on a C code library that was written by Canadian Forest Service Employees, which was originally based on the Fortran code listed in the reference below. All equations in this code refer to that document. Equations and FORTRAN program for the Canadian Forest Fire Weather Index System. 1985. Van Wagner, C.E.; Pickett, T.L. Canadian Forestry Service, Petawawa National Forestry Institute, Chalk River, Ontario. Forestry Technical Report 33. 18 p. Additional reference on FWI system Development and structure of the Canadian Forest Fire Weather Index System. 1987. Van Wagner, C.E. Canadian Forestry Service, Headquarters, Ottawa. Forestry Technical Report 35. 35 p.

Usage

```
DroughtCode(dc_yda, temp, rh, prec, lat, mon, lat.adjust = TRUE)
```

Arguments

dc_yda	The Drought Code from previous iteration
temp	Temperature (centigrade)
rh	Relative Humidity (%)
prec	Precipitation(mm)
lat	Latitude (decimal degrees)
mon	Month (1-12)
lat.adjust	Latitude adjustment (TRUE, FALSE, default=TRUE)

Value

A single drought code value

References

http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/19927.pdf Development and structure of the Canadian Forest Fire Weather Index System. 1987. Van Wagner, C.E. Canadian Forestry Service, Headquarters, Ottawa. Forestry Technical Report 35. 35 p.

DuffMoistureCode *Duff Moisture Code Calculator*

Description

Duff Moisture Code Calculation. All code is based on a C code library that was written by Canadian Forest Service Employees, which was originally based on the Fortran code listed in the reference below. All equations in this code refer to that document.

Usage

```
DuffMoistureCode(dmc_yda, temp, rh, prec, lat, mon, lat.adjust = TRUE)
```

Arguments

dmc_yda	The Duff Moisture Code from previous iteration
temp	Temperature (centigrade)
rh	Relative Humidity (%)
prec	Precipitation(mm)
lat	Latitude (decimal degrees)
mon	Month (1-12)
lat.adjust	Latitude adjustment (TRUE, FALSE, default=TRUE)

Details

Equations and FORTRAN program for the Canadian Forest Fire Weather Index System. 1985. Van Wagner, C.E.; Pickett, T.L. Canadian Forestry Service, Petawawa National Forestry Institute, Chalk River, Ontario. Forestry Technical Report 33. 18 p.

Additional reference on FWI system

Development and structure of the Canadian Forest Fire Weather Index System. 1987. Van Wagner, C.E. Canadian Forestry Service, Headquarters, Ottawa. Forestry Technical Report 35. 35 p.

Value

A single duff moisture code value

References

http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/19927.pdf Development and structure of the Canadian Forest Fire Weather Index System. 1987. Van Wagner, C.E. Canadian Forestry Service, Headquarters, Ottawa. Forestry Technical Report 35. 35 p.

FineFuelMoistureCode *Fine Fuel Moisture Code Calculation*

Description

Fine Fuel Moisture Code Calculation. All code is based on a C code library that was written by Canadian Forest Service Employees, which was originally based on the Fortran code listed in the reference below. All equations in this code refer to that document.

Usage

```
FineFuelMoistureCode(ffmc_yda, temp, rh, ws, prec)
```

Arguments

ffmc_yda	The Fine Fuel Moisture Code from previous iteration
temp	Temperature (centigrade)
rh	Relative Humidity (%)
ws	Wind speed (km/h)
prec	Precipitation (mm)

Details

Equations and FORTRAN program for the Canadian Forest Fire Weather Index System. 1985. Van Wagner, C.E.; Pickett, T.L. Canadian Forestry Service, Petawawa National Forestry Institute, Chalk River, Ontario. Forestry Technical Report 33. 18 p.

Additional reference on FWI system Development and structure of the Canadian Forest Fire Weather Index System. 1987. Van Wagner, C.E. Canadian Forestry Service, Headquarters, Ottawa. Forestry Technical Report 35. 35 p.

Value

A single fine fuel moisture code value

FireBehaviourPrediction

Fire Behaviour Prediction System Calculation (hidden)

Description

Fire Behavior Prediction System calculations. This is the primary function for calculating FBP for a single timestep. Not all equations are calculated within this function, but have been broken down further.

Usage

```
FireBehaviourPrediction(input = NULL, output = "Primary")
```

Arguments

input	Data frame of required and optional information needed to calculate FBP function. View the arguments section of the fbp manual (fbp.Rd) under "input" for the full listing of the required and optional inputs.
output	What fbp outputs to return to the user. Options are "Primary", "Secondary" and "All". _Default:_ "Primary"

Value

output: Either Primary, Secondary, or all FBP outputs in a data.frame

FireIntensity *Fire Intensity Calculator*

Description

Calculate the Predicted Fire Intensity

Usage

```
FireIntensity(FC, ROS)
```

Arguments

FC	Fuel Consumption (kg/m^2)
ROS	Rate of Spread (m/min)

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

FI: Fire Intensity (kW/m)

FireWeatherIndex *Fire Weather Index Calculation.*

Description

All code is based on a C code library that was written by Canadian Forest Service Employees, which was originally based on the Fortran code listed in the reference below. All equations in this code refer to that document.

Usage

```
FireWeatherIndex(isi, bui)
```

Arguments

isi	Initial Spread Index
bui	Buildup Index

Details

Equations and FORTRAN program for the Canadian Forest Fire Weather Index System. 1985. Van Wagner, C.E.; Pickett, T.L. Canadian Forestry Service, Petawawa National Forestry Institute, Chalk River, Ontario. Forestry Technical Report 33. 18 p.

Additional reference on FWI system

Development and structure of the Canadian Forest Fire Weather Index System. 1987. Van Wagner, C.E. Canadian Forestry Service, Headquarters, Ottawa. Forestry Technical Report 35. 35 p.

Value

A single fwi value

`FlankRateOfSpread` *Flank Fire Rate of Spread Calculator*

Description

Calculate the Flank Fire Spread Rate.

Usage

```
FlankRateOfSpread(ROS, BROS, LB)
```

Arguments

`ROS`	Fire Rate of Spread (m/min)
`BROS`	Back Fire Rate of Spread (m/min)
`LB`	Length to breadth ratio

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

FROS Flank Fire Spread Rate (m/min) value

FoliarMoistureContent *Foliar Moisture Content Calculator*

Description

Calculate Foliar Moisture Content on a specified day. All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Usage

```
FoliarMoistureContent(LAT, LONG, ELV, DJ, D0)
```

Arguments

LAT	Latitude (decimal degrees)
LONG	Longitude (decimal degrees)
ELV	Elevation (metres)
DJ	Day of year (offeren referred to as julian date)
D0	Date of minimum foliar moisture content. _If D0, date of min FMC, is not known then D0 = NULL._

Value

FMC: Foliar Moisture Content value

InitialSpreadIndex *Initial Spread Index Calculator*

Description

Computes the Initial Spread Index From the FWI System. Equations are from Van Wagner (1985) as listed below, except for the modification for fbp takene from FCFDG (1992).

Usage

```
InitialSpreadIndex(ffmc, ws, fbpMod = FALSE)
```

Arguments

ffmc	Fine Fuel Moisture Code
ws	Wind Speed (km/h)
fbpMod	TRUE/FALSE if using the fbp modification at the extreme end

Details

Equations and FORTRAN program for the Canadian Forest Fire Weather Index System. 1985. Van Wagner, C.E.; Pickett, T.L. Canadian Forestry Service, Petawawa National Forestry Institute, Chalk River, Ontario. Forestry Technical Report 33. 18 p.

Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical ReportST-X-3, Forestry Canada, Ottawa, Ontario.

Value

ISI - Initial Spread Index

`IntermediateSurfaceRateOfSpreadC6` *C-6 Conifer Plantation Intermediate Surface Fire Spread Rate Calculator*

Description

Calculate intermediate surface fire rate of spread, before BUI effect is applied (RSI).

Usage

```
IntermediateSurfaceRateOfSpreadC6(ISI, FMC)
```

Arguments

`ISI`	Initial Spread Index
`FMC`	Foliar Moisture Content

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

RSI

References

https://cfs.nrcan.gc.ca/publications/download-pdf/10068 Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

LengthToBreadthRatio *Length-to-Breadth ratio*

Description

Computes the Length to Breadth ratio of an elliptically shaped fire. Equations are from listed FCFDG (1992) except for errata 80 from Wotton et. al. (2009).

Usage

```
LengthToBreadthRatio(FUELTYPE, WSV)
```

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p.

@param FUELTYPE The Fire Behaviour Prediction FuelType @param WSV The Wind Speed (km/h)

Value

Length to Breadth ratio value

LengthToBreadthRatioAtTime *Length-to-Breadth ratio at time t*

Description

Computes the Length to Breadth ratio of an elliptically shaped fire at elapsed time since ignition. Equations are from listed FCFDG (1992) and Wotton et. al. (2009), and are marked as such.

Usage

```
LengthToBreadthRatioAtTime(FUELTYPE, LB, HR, CFB)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
LB:	Length to Breadth ratio
HR:	Time since ignition (hours)
CFB:	Crown Fraction Burned

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p.

Value

Length to Breadth ratio at time since ignition

RateOfSpread *Rate of Spread Calculation*

Description

Computes the Rate of Spread prediction based on fuel type and FWI conditions. Equations are from listed FCFDG (1992) and Wotton et. al. (2009), and are marked as such.

Usage

```
RateOfSpread(FUELTYPE, ISI, BUI, FMC, SFC, PC, PDF, CC, CBH)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
ISI	Intiial Spread Index
BUI	Buildup Index
FMC	Foliar Moisture Content
SFC	Surface Fuel Consumption (kg/m^2)
PC	Percent Conifer (%)
PDF	Percent Dead Balsam Fir (%)
CC	Constant
CBH	Crown to base height(m)

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p.

Value

ROS - Rate of Spread (m/min) value

RateOfSpreadAtTheta *Rate of spread at a point along the perimeter calculator*

Description

Computes the Rate of Spread at any point along the perimeter of an elliptically shaped fire. Equations are from Wotton et. al. (2009).

Usage

```
RateOfSpreadAtTheta(ROS, FROS, BROS, THETA)
```

Arguments

ROS	Rate of Spread (m/min)
FROS	Flank Fire Rate of Spread (m/min)
BROS	Back Fire Rate of Spread (m/min)
THETA	
FUELTYPE	The Fire Behaviour Prediction FuelType

Details

Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p.

Value

ROSTHETA - Rate of spread at point theta(m/min)

RateOfSpreadAtTime *Rate of spread at time t calculation*

Description

Computes the Rate of Spread prediction based on fuel type and FWI conditions at elapsed time since ignition. Equations are from listed FCFDG (1992).

Usage

```
RateOfSpreadAtTime(FUELTYPE, ROSeq, HR, CFB)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
ROSeq	Equilibrium Rate of Spread (m/min)
HR	Time since ignition (hours)
CFB	Crown Fraction Burned

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

ROSt - Rate of Spread at time since ignition value

RateOfSpreadC6 *C-6 Conifer Plantation Fire Spread Calculator*

Description

Calculate rate of spread (ROS).

Usage

```
RateOfSpreadC6(RSC, RSS, CFB)
```

Arguments

RSC	Crown Fire Spread Rate (m/min)
RSS	Surface Fire Spread Rate (m/min)
CFB	Crown Fraction Burned

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

ROS

References

https://cfs.nrcan.gc.ca/publications/download-pdf/10068 Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

sdmc *Sheltered Duff Moisture Code*

Description

sdmc is used to calculate sheltered DMC (sDMC, Wotton et al., 2005) based on daily noon weather observations of temperature, relative humidity, wind speed, 24-hour rainfall, and a previous day's calculated or estimated value of sDMC. This function calculates sDMC for either one weather station or for multiple weather stations over the duration of the daily weather data set, typically over a fire season.

Usage

```
sdmc(input, sdmc_old = NULL, batch = TRUE)
```

Arguments

input	A data.frame containing input variables of daily noon weather observations. Variable names have to be the same as in the following list, but they are case insensitive. The order in which the input variables are entered is not important either.		
	temp	(required)	Temperature (centigrade)
	rh	(required)	Relative humidity (%)
	ws	(required)	10-m height wind speed (km/h)
	prec	(required)	1-hour rainfall (mm)
	mon	(recommended)	Month of the observations (integer 1-12)
	day	(optional)	Day of the observations (integer)
sdmc_old	Previous day's value of SDMC. At the start of calculations, when there is no calculated previous day's SDMC value to use, the user must specify an estimate of this value. Where sdmc_old=NULL, the function will calculate the initial SDMC values based on the initial DMC. The sdmc_old argument can accept a single initial value for multiple weather stations, and also accept a vector of initial values for multiple weather stations.		
batch	Whether the computation is iterative or single step, default is TRUE. When batch=TRUE, the function will calculate daily SDMC for one weather station over a period of time iteratively. If multiple weather stations are processed, an additional "id" column is required in the input to label different stations, and the data needs to be sorted by date/time and "id". If batch=FALSE, the function calculates only one time step base on either the previous day's SDMC or the initial start value.		

Details

The Duff Moisture Code (DMC) component of the Canadian Forest Fire Weather Index (FWI) System tracks moisture content of the forest floor away from the sheltering influences of overstory trees. This sheltered Duff Moisture Code (sDMC) was developed to track moisture in the upper 5 cm of the organic layer in the rain sheltered areas near (<0.5 m) the boles of overstory trees (Wotton et al. 2005), an area where lightning strikes usually ignite the forest floor when they run

to ground. The sDMC is very similar in structure (and identical in data requirements) to the DMC. The sDMC, like all the FWI System moisture codes, is a bookkeeping system that tracks gain and loss of moisture from day-to-day; thus an estimate of the previous day's sDMC value is needed to provide a starting point for each day's moisture calculation. Like the other moisture codes in the FWI System the sDMC is converted from a moisture content value to an outputted CODE value which increases in value with decreasing moisture content.

Value

sdmc returns either a single value or a vector of SDMC values.

Author(s)

Xianli Wang, Mike Wotton, Alan Cantin, and Mike Flannigan

References

Wotton, B.M., B.J. Stocks, and D.L. Martell. 2005. An index for tracking sheltered forest floor moisture within the Canadian Forest Fire Weather Index System. International Journal of Wildland Fire, 14, 169-182.

See Also

fwi

Examples

```
library(cffdrs)
data("test_sdmc")
#order the data:
test_sdmc<-test_sdmc[with(test_sdmc,order(yr,mon,day)),]
# (1)Default of sdmc, calculate sdmc for a chronical period
# of time.
# Because sdmc_old is better to be calculated, we normally
# ignore this option:
test_sdmc$SDMC<-sdmc(test_sdmc)
# (2) multiple weather stations:
# Batch process with multiple stations (2 stations) assuming
# they are from the same month:
test_sdmc$mon<-7
test_sdmc$day<-rep(1:24,2)
test_sdmc$id<-rep(1:2,each=24)
# Sort the data by date and weather station id:
test_sdmc<-test_sdmc[with(test_sdmc,order(yr,mon,day,id)),]
# Apply the function
test_sdmc$SDMC_mult_stn<-sdmc(test_sdmc,batch=TRUE)
# Assuming each record is from a different weather station, and
# calculate only one time step:
  foo<-sdmc(test_sdmc,batch=FALSE)
```

`ShelteredDuffMoistureCode` *Sheltered Duff Moisture Code*

Description

`ShelteredDuffMoistureCode` is used to calculate sheltered DMC (sDMC, Wotton et al., 2005) based on daily noon weather observations of temperature, relative humidity, 24-hour rainfall, and a previous day's calculated or estimated value of sDMC. This function calculates sDMC for either one weather station or for multiple weather stations over the duration of the daily weather data set, typically over a fire season.

Usage

```
ShelteredDuffMoistureCode(temp, prec, rh, dmc, mon, sdmc_old = NULL)
```

Arguments

`sdmc_old` Previous day's value of SDMC. At the start of calculations, when there is no calculated previous day's SDMC value to use, the user must specify an estimate of this value. Where `sdmc_old=NULL`, the function will calculate the initial SDMC values based on the initial DMC. The `sdmc_old` argument can accept a single initial value for multiple weather stations, and also accept a vector of initial values for multiple weather stations.

`input` A data.frame containing input variables of daily noon weather observations. Variable names have to be the same as in the following list, but they are case insensitive. The order in which the input variables are entered is not important either.

temp	(required)	Temperature (centigrade)
rh	(required)	Relative humidity (%)
prec	(required)	1-hour rainfall (mm)
mon	(recommended)	Month of the observations (integer 1-12)
day	(optional)	Day of the observations (integer)

`batch` Whether the computation is iterative or single step, default is TRUE. When `batch=TRUE`, the function will calculate daily SDMC for one weather station over a period of time iteratively. If multiple weather stations are processed, an additional "id" column is required in the input to label different stations, and the data needs to be sorted by date/time and "id". If `batch=FALSE`, the function calculates only one time step base on either the previous day's SDMC or the initial start value.

Details

The Duff Moisture Code (DMC) component of the Canadian Forest Fire Weather Index (FWI) System tracks moisture content of the forest floor away from the sheltering influences of overstory trees. This sheltered Duff Moisture Code (sDMC) was developed to track moisture in the upper 5 cm of the organic layer in the rain sheltered areas near (<0.5 m) the boles of overstory trees (Wotton et al. 2005), an area where lightning strikes usually ignite the forest floor when they run

to ground. The sDMC is very similar in structure (and identical in data requirements) to the DMC. The sDMC, like all the FWI System moisture codes, is a bookkeeping system that tracks gain and loss of moisture from day-to-day; thus an estimate of the previous day's sDMC value is needed to provide a starting point for each day's moisture calculation. Like the other moisture codes in the FWI System the sDMC is converted from a moisture content value to an outputted CODE value which increases in value with decreasing moisture content.

Value

`ShelteredDuffMoistureCode` returns either a single value or a vector of SDMC values.

Author(s)

Xianli Wang, Mike Wotton, Alan Cantin, and Mike Flannigan

References

Wotton, B.M., B.J. Stocks, and D.L. Martell. 2005. An index for tracking sheltered forest floor moisture within the Canadian Forest Fire Weather Index System. International Journal of Wildland Fire, 14, 169-182.

See Also

`fwi`

`SlopeAdjust` *Slope Adjusted wind speed or slope direction of spread calculation*

Description

Calculate the net effective windspeed (WSV), the net effective wind direction (RAZ) or the wind azimuth (WAZ).

Usage

```
SlopeAdjust(
  FUELTYPE,
  FFMC,
  BUI,
  WS,
  WAZ,
  GS,
  SAZ,
  FMC,
  SFC,
  PC,
  PDF,
  CC,
  CBH,
  ISI
)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
BUI	The Buildup Index value
WS	Windspeed (km/h)
WAZ	Wind Azimuth
GS	Ground Slope (%)
SAZ	Slope Azimuth
FMC	Foliar Moisture Content
SFC	Surface Fuel Consumption (kg/m^2)
PC	Percent Conifer (%)
PDF	Percent Dead Balsam Fir (%)
CC	Constant
CBH	Crown Base Height (m)
ISI	Initial Spread Index
output	Type of variable to output (RAZ/WSV, default=RAZ)

Details

All variables names are laid out in the same manner as FCFDG (1992) and Wotton (2009).

Forestry Canada Fire Danger Group (FCFDG) (1992). "Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p.

Value

list(RAZ, WSV) - Rate of spread azimuth (degrees) and Wind Slope speed (km/hr)

SurfaceFuelConsumption

Surface Fuel Consumption Calculator

Description

Computes the Surface Fuel Consumption by Fuel Type. All variables names are laid out in the same manner as FCFDG (1992) or Wotton et. al (2009)

Forestry Canada Fire Danger Group (FCFDG) (1992). "Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Usage

```
SurfaceFuelConsumption(FUELTYPE, FFMC, BUI, PC, GFL)
```

Arguments

FUELTYPE	The Fire Behaviour Prediction FuelType
FFMC	Fine Fuel Moisture Code
BUI	Buildup Index
PC	Percent Conifer (%)
GFL	Grass Fuel Load (kg/m^2)

Details

Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p.

Value

SFC Surface Fuel Consumption (kg/m^2)

SurfaceRateOfSpreadC6 *C-6 Conifer Plantation Fire Spread Calculator*

Description

Calculate surface fire rate of spread (RSS).

Usage

```
SurfaceRateOfSpreadC6(RSI, BUI)
```

Arguments

RSI	Intermediate Surface Fire Rate of Spread
BUI	Buildup Index
FUELTYPE	The Fire Behaviour Prediction FuelType

Details

All variables names are laid out in the same manner as Forestry Canada Fire Danger Group (FCFDG) (1992). Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Value

RSS

References

https://cfs.nrcan.gc.ca/publications/download-pdf/10068 Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

`TotalFuelConsumption` *Total Fuel Consumption calculation*

Description

Computes the Total (Surface + Crown) Fuel Consumption by Fuel Type. All variables names are laid out in the same manner as FCFDG (1992) or Wotton et. al (2009)

Forestry Canada Fire Danger Group (FCFDG) (1992). "Development and Structure of the Canadian Forest Fire Behavior Prediction System." Technical Report ST-X-3, Forestry Canada, Ottawa, Ontario.

Usage

```
TotalFuelConsumption(CFC, SFC)
```

Arguments

`CFC`	Crown Fuel Consumption (kg/m^2)
`SFC`	Surface Fuel Consumption (kg/m^2)

Details

Wotton, B.M., Alexander, M.E., Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian forest fire behavior prediction system. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, Ontario, Canada. Information Report GLC-X-10, 45p.

Value

TFC Total (Surface + Crown) Fuel Consumption (kg/m^2)

Index