Package 'firebehavioR'

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Title Prediction of wildland fire behavior

Version 0.0.0.9000

Description Functions for estimating wildland fire behavior using common models in the US.

Depends R (>= 3.4.1)

License GPL-2

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R topics documented:

`canFuel` *Canopy Fuel Stratum Characteristics Calculator*

Description

Canopy parameters estimated by Cruz, Alexander & Wakimoto (2003)

Usage

```
canFuel(ba, ht, tph, type)
```

Arguments

ba	a vector or data frame with stand basal area (m2/ha)
ht	a vector or data frame with average stand height (m)
tph	a vector or data frame with stand density (trees/ha)
type	a vector or data frame with forest cover type, either: "df" for Douglas-fir (*Pseudotsuga menziesii*); "pp" for ponderosa pine (*Pinus ponderosa*); "lp" for lodgepole pine (*Pinus contorta*); "mc" for mixed conifer

Value

a data frame with canopy base height (m), canopy fuel load (kg/m2), and canopy bulk density (kg/m3)

Author(s)

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References

Cruz M.G., Alexander M.E., Wakimoto R.H. 2003. Assessing canopy fuel stratum characteristics in crown fire prone fuel types of western North America. *International Journal of Wildland Fire*. **12**(1):39-50.

See Also

This function provides values for nexus and cfis inputs.

Examples

```
library(firebehavioR)
```

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cfis *Canopy Fire Initiation & Spread model*

Description

Prediction of crown fire probability, crown fire rate of spread and seperation distance (Alexander and Cruz 2006). Seperation distance is distance ahead of main fire front required for a spot fire to form, seperate of a main fire.

Usage

```
cfis(fsg, u10, effm, sfc, cbd, id)
```

Arguments

fsg	a vector or data frame of fuel stratum gap (m)
u10	a vector or data frame with open (at a height 10 m above the canopy) wind speed (km/hr)
effm	a vector or data frame with effective fine fuel moisture (%)
sfc	a vector or data frame of surface fuel consumed (kg/m2)
cbd	a vector or data frame of canopy bulk density (kg/m3)
id	a vector or data frame of spot ignition delay, the time during which a given firebrand generates, is transported aloft, and ignites a receptive fuelbed (min)

Value

a data frame with type of fire, probability of crown fire occurences (%), crown fire rate of spread (m/min), and critical spotting distance (m)

Author(s)

Justin P Ziegler, <justin.ziegler@colostate.edu>

References

Alexander M.E., Cruz M.G. 2006. Evaluating a model for predicting active crown fire rate of spread using wildfire observations. *Canadian Journal of Forest Research*. **36**:2015-3028.

Examples

```
library(firebehavioR)
```

---

fuelModels *Surface fuel models.*

Description

Fuel models developed by Anderson (1982), Scott (1999), and Scott & Burgan (2005) for prediction of surface fire behavior.

Usage

```
data(fuelModels)
```

Format

A data frame with 60 observations of 18 variables:

fuelModelType "S"tatic or "D"ynamic fuel load transfer

loadLitter load of litter fuel (Mg/ha)

load1hr load of 1-hr fuel (Mg/ha)

load10hr load of 10-hr fuel (Mg/ha)

load100hr load of 100-hr fuel (Mg/ha)

loadLiveHerb load of herbaceous fuel (Mg/ha)

loadLiveWoody load of woody fuel(Mg/ha)

savLitter surface area to volume ratio of litter fuel (m2/m3)

sav1hr surface area to volume ratio of 1-hr fuel (m2/m3)

sav10hr surface area to volume ratio of 10-hr fuel (m2/m3)

sav100hr surface area to volume ratio of 100-hr fuel (m2/m3)

savLiveHerb surface area to volume ratio of herbaceous fuel (m2/m3)

savLiveWoody surface area to volume ratio of woody fuel (m2/m3)

fuelBedDepth depth of woody fuel (cm)

mxDead dead fuel moisture of extincton (%)

heat heat content (J/g)

description fuel model description

source scientific source

References

Anderson, H.E. 1982. Aids to determining fuel models for estimating fire behavior. *INT-GTR-122*. US Department of Agriculture, Forest Service, Intermountain Forest and Range Experimental Station.
Scott, J.H. 1999. NEXUS: A system for assessing crown fire hazard. *Fire Management Notes* **59**(2):20 –24.
Scott, J.H., & Burgan, R. E. 2005. A new set of standard fire behavior fuel models for use with Rothermel's surface fire spread model. *RMRS-GTR-153*. US Department of Agriculture, Forest Service, Rocky Mountain Research Station.

See Also

nexus

`fuelMoisture` *Modified Scott & Burgan (2005) moisture scenarios.*

Description

Moisture scenarios are a set of fuel moistures of surface fuels, on a dry-weight basis, for each of the surface fuel classes. Originally developed by Scott & Burgan (2005), this dataset includes fuel moistures of litter.

Usage

```
data(fuelMoisture)
```

Format

A data frame with 16 observations of 7 variables:

fmLitter moisture of litter (%)

fm1hr moisture of 1-hr fuel (%)

fm10hr moisture of 10-hr fuel (%)

fm100hr moisture of 100-hr fuel (%)

fmLiveHerb moisture of herbaceous fuel (%)

fmLiveWoody moisture of woody fuel (%)

description scenario description

Source

Scott, J., & Burgan, R. E. 2005. A new set of standard fire behavior fuel models for use with Rothermel's surface fire spread model. *RMRS-GTR-153*. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station.

See Also

`nexus`

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nexus *Nexus Fire Behavior Modeling System*

Description

Potential surface and crown fire behavior predicted by Scott and Reinhardt (2001).

Usage

```
nexus(surfFuel, moisture, crownFuel, enviro, rosMult = 1,
  cfbForm = "f")
```

Arguments

`surfFuel` a vector or data frame of surface fuel attributes. Variable names are not important but the order is important.

1. the fuel model type, either 'S'tatic or D'ynamic herb load transfer
2. litter load (Mg/ha)
3. 1-hr load (Mg/ha)
4. 10-hr load (Mg/ha)
5. 100-hr load (Mg/ha)
6. herb load (Mg/ha)
7. woody load (Mg/ha)
8. litter SAV (m2/m3)
9. 1-hr SAV (m2/m3)
10. 10-hr SAV (m2/m3)
11. 100-hr SAV (m2/m3)

12. herb SAV (m2/m3)
13. woody SAV (m2/m3)
14. fuel bed depth (cm)
15. moisture of extinction (%)
16. heat content (J/g)

`moisture` a vector or data frame of fuel moistures on a dry-weight basis (%) for litter, 1-hr 10-hr, 100-hr, herbaceous, and woody fuel classes, in order (6 values or columns)

`crownFuel` a vector or data frame with canopy fuel attributes consisting of: canopy bulk density (kg/m3); foliar moisture content (%); canopy base height (m); and canopy fuel load (kg/m2), in order (4 values or columns)

`enviro` a vector or data frame of environmental variables including: topographic slope (%); open windspeed (km/hr); wind direction, from uphill (deg.); and wind adjustment factor (0-1), respectively (4 values or columns)

`rosMult` a numeric value for multiplying crown fire rate of spread, defaults to 1 (see details)

`cfbForm` a character string specifying how crown fraction burned is calculated. Options are "sr", "w", or "f" (default); see details.

Details

This in an R build of the Nexus fire behavior modeling system (Scott & Reinhardt 2001) which links sub-models of surface fire rate of spread (Rothermel 1972), crown fire initiation (Van Wagner 1977), and Rothermel's (1991) crown fire rate of spread.
`rosMult` multiples the rate of spread for active or passive crown fires and is recommended a value of 1.7 when a user desires a maximum crown fire rate of spread (Rothermel 1991).
`cfbForm` selects the method to estimate crown fraction burned. This selection impacts estimates of passive crown fraction burned, fireline intensity, and heat per unit area. Use "sr" for Scott and Reinhardt (2001), "w" for van Wagner (1993), and "f" for Finney (1998).

Value

a list with 6 data frames

`fireBehavior` a data frame with fire behavior estimates including fire type, crown fraction burned (%), rate of spread (m/min), heat per unit area (kW/m2), fireline intensity (kW/m), flame length (m), direction of max spread (deg), scorch height (m), torching index (m/min), crowning index (m/min), surfacing index (m/min), effective midflame wind (m/min), flame residence time (min)

`detailSurface` a data frame with some intermediate variables of surface fire behavior including: potential ROS (m/min); no wind, no slope ROS (m/min); slope factor (-); wind factor (-); characteristic dead fuel moisture (%); characteristic live fuel moisture (%); characteristic SAV (m2/m3); bulk density (kg/m3); packing ratio (-); relative packing ratio (-); reaction intensity (kW/m2); heat source (kW/m2); heat sink (kJ/m3)

`detailCrown` a data frame with some intermediate variables of crown fire behavior including: potential ROS (m/min); no wind, no slope ROS (m/min); slope factor (-); wind factor (-); characteristic dead fuel moisture (%); characteristic live fuel moisture (%); characteristic SAV (m2/m3); bulk density (kg/m3); packing ratio (-); relative packing ratio (-); reaction intensity (kW/m2); heat source (kW/m2); heat sink (kJ/m3)

critInit	a data frame of critical values for crown fire initiation including: fireline intensity (kW/m), flame length (m), surface ROS (m/min), Canopy base height (m)
critActive	a data frame of critical values for active crown fire including: canopy bulk density (kg/m3)", "ROS, crown (R'active) (m/min)
critCess	a data frame of critical values for cessation of crown fire including: canopy base height (m), O'cessation (m/min)

Author(s)

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References

Rothermel, R.C. 1972. A mathematical model for predicting fire spread in wildland fuels. *INT-RP-115*. USDA Forest Service Intermountain Forest & Range Experimental Station.
Van Wagner, C.E. 1977. Conditions for the start and spread of crown fire. *Canadian Journal of Forest Research* **7**:23–34.
Rothermel, R.C., 1991. Predicting behavior and size of crown fires in the northern Rocky Mountains. *INT-RP-438*. USDA Forest Service Intermountain Research Station.
Van Wagner, C.E. 1993. Prediction of crown fire behavior in two stands of jack pine. *Canadian Journal of Forest Research* **23**:442–449.
Finney, M.A. 1998. FARSITE: Fire area simulator — model development and evaluation. *RMRS-RP-47*. USDA Forest Service Rocky Mountain Research Station.
Scott, J.H., Reinhardt, E.D. 2001. Assessing crown fire potential by linking models of surface and crown fire behavior. *RMRS-RP-29*. USDA Forest Service Rocky Mountain Research Station.

Examples

```
library(firebehavioR)
```

---

waf *Calculated wind adjustment factor*

Description

Prediction of wind adjustment factor for sheltered and unsheltered fuels.

Usage

```
waf(fuelDepth, forestHt, cr, cc, sheltered = "n")
```

Arguments

fuelDepth	a vector for depths of surface fuel bed (cm)
forestHt	a vector of average stand tree heights (m)
cr	a vector of crown ratios (%)
cc	a vector of canopy cover (%)
sheltered	a vector of either "y"es or "n"o as flags for using sheltered or unsheltered equations

Details

This calculates the wind adjustment factor (ratio of 10-m open wind speed to wind speed at the height of a surface fire). One of two equations are used, depending on user input. By default, this function assumes the surface fuel bed is unsheltered. `fuelDepth` must be a positive value if the unsheletered variant is invoked. `forestHt` must be a positive value if the sheletered variant is invoked. There are two conditions to enable calculation for a sheltered fuelbed. First, if user could enter values for `cr` and `cc` that lead to a crown fill portion above 5%, or the user could enter `"y"` for `sheltered`. In the latter case, this function assumes a crown fill portion of 10%.

Value

a vector of wind adjustment factors

Author(s)

Justin P Ziegler, <justin.ziegler@colostate.edu>

References

Andrews, P.L. 2012. Modeling wind adjustment factor and midflame wind speed for Rothermel's surface fire spread model. *RMRS-GTR-266*. USDA Forest Service Rocky Mountain Research Station.

Examples

```
library(firebehavioR)
```

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