Package 'sitreeE'

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Title Sitree Extensions

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Depends R (>= 3.1.0), sitree, data.table

Description Provides extensions for package 'sitree' for allometric variables, growth, mortality, recruitment, management, tree removal and external modifiers functions.

License GPL (>= 2)

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LazyLoad yes

LazyData yes

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AM2016ClimateSensitiveSINorway

Climate-sensitive site index models for Norway

Description

Implementation of models for climate-sensitive site index models for Norway as described in Antón-Fernández et al. (2016).

Usage

```
AM2016ClimateSensitiveSINorway(soilquality, t.early.summer, waterbal, SI.spp)
```

Arguments

soilquality	A factor with levels 1 to 5 indicating the soilquality category. 1 being the poorest soils and 5 the best soils
t.early.summer	A vector with sum temperatures (in C) in spring and early summer (april, june and july)
waterbal	A vector with the montly moisture surplus in June (difference between the 30-year mean precipitation in June and mean potential evapotranspiration in June.).
SI.spp	SI species, that is, the species for which SI should be calculated. 1 = spruce, 2 = pine, 3 = birch.

Value

Returns a vector with the estimated SI.

Author(s)

Clara Anton-Fernandez

References

Anton-Fernandez, Clara, Blas Mola-Yudego, Lise Dalsgaard, and Rasmus Astrup. 2016. "Climate-Sensitive Site Index Models for Norway." Canadian Journal of Forest Research 46 (6)

Examples

```
AM2016ClimateSensitiveSINorway (soilquality = as.factor(c(1,2,3,4)),
                                t.early.summer = c(10,20,30,10),
                                waterbal = c(-40, 20,10,10),
                                SI.spp = c(1,2,2,3))
```

---

biomass.birch.M1988   *Marklund's biomass equations*

Description

Implements Marklund's (1988) biomass equations for above-ground biomass and Petersson and Ståhl (2006) for below-ground biomass.

Usage

```
biomass.spruce.M1988(dbh.cm, H.m)
biomass.pine.M1988(dbh.cm, H.m)
biomass.birch.M1988(dbh.cm, H.m)
```

Arguments

dbh.cm	A vector with the dbh (diameter at breast height) of the trees, in cm.
H.m	A vector with the heights of the trees, in meters.

Value

It returns a data.frame with the following biomass components in kg: living.branches, dead.branches, stem.wood, stump.roots, bark, usoil, rot1, rot2, and foliage.

Author(s)

Clara Anton Fernandez <caf@nibio.no>

References

Marklund, L. G. 1988. "Biomassafunktioner för tall, gran och björk i Sverige [Biomass functions for pine, spruce and birch in Sweden]." Report 45. Umeå, Sweden: Swedish University of Agricultural Sciences. Department of Forest Survey. Petersson, Hans, and Göran Ståhl. 2006. "Functions for Below-Ground Biomass of Pinus Sylvestris, Picea Abies, Betula Pendula and Betula Pubescens in Sweden." Scandinavian Journal of Forest Research 21 (S7): 84–93.

Examples

```
biomass.spruce.M1988(dbh.cm = c(10, 20), H.m = c(8, 12))
```

---

biomass.birch.S2014   *Implements biomass functions for birch for Norway from Smith et al*
                         (2014, 2016)

Description

Implements biomass functions for birch for Norway from Smith et al (2014, 2016). Total biomass
aboveground does include stump calculated using biomass.birch.M1988. Total biomass below-
ground does not include stump.

Usage

```
biomass.birch.S2014(dbh.cm, H.m)
```

Arguments

dbh.cm

H.m

Details

It uses stump.roots from biomass.birch.M1988 to calculate aboveground biomass (in kg) and be-
lowground biomass (in kg). Aboveground biomass is calculated as Smith's aboveground biomass
(2014) + stump.roots. Belowground biomass is calcualted as Smith's belowground biomass (2016)
- stump.roots.

Value

Returns a data.frame with the following biomass components: biomass.total.kg, biomass.aboveground.kg.S2014,
biomass.belowground.kg.S2014, biomass.belowground.kg, biomass.aboveground.kg, living.branches,
dead.branches, stem.wood, stump.roots, bark, usoil, rot1, rot2, foliage)

Author(s)

Clara Anton Fernandez (caf@nibio.no)

References

Smith, Aaron, Aksel Granhus, and Rasmus Astrup. 2016. "Functions for Estimating Belowground
and Whole Tree Biomass of Birch in Norway." Scandinavian Journal of Forest Research 31 (6):
568–82. Smith, Aaron, Aksel Granhus, Rasmus Astrup, Ole Martin Bollandsås, and Hans Peters-
son. 2014. "Functions for Estimating Aboveground Biomass of Birch in Norway." Scandinavian
Journal of Forest Research 29 (6): 565–78.

See Also

[biomass.Norway,](biomass.Norway) biomass.birch.M1988

Examples

```
biomass.birch.S2014(dbh.cm = c(10, 20), H.m = c(12, 16))
```

---

biomass.M1988 *Biomass functions of Marklund (1988) and Petterson and Sthål (2006)*

Description

It implements Marklund (1988) -G20, G12, G16, G8, G5, G26, G31, G28- and Petterson & Sthål (2006) equation for roots < 2mm.

Usage

```
biomass.M1988(tr, spp, this.period)
```

Arguments

tr	A trList or trListDead object.
spp	A vector with the species for each tree in the tr object. The species can be "spruce", "pine", "birch", or "other" (which is treated as birch).
this.period	The period for which biomass should be calculated, e.g. "t1".

Value

It returns a data frame with columns for living branches, dead branches, stem, stump, bark, stump roots, roots1, roots2, and foliage. Units are kg.

Author(s)

Clara Anton Fernandez (caf@nibio.no)

References

Marklund, L. G. 1988. "Biomassafunktioner för tall, gran och björk i Sverige (Biomass functions for pine, spruce and birch in Sweden)." Report 45. Umeå, Sweden: Swedish University of Agricultural Sciences. Department of Forest Survey.

Petersson, Hans, and Göran Ståhl. 2006. "Functions for Below-Ground Biomass of Pinus Sylvestris, Picea Abies, Betula Pendula and Betula Pubescens in Sweden." Scandinavian Journal of Forest Research 21 (S7): 84–93. doi:10.1080/14004080500486864.

Examples

```
res <- sitree (tree.df  = tr,
               stand.df  = fl,
               functions = list(
                   fn.growth     = 'grow.dbhinc.hgtinc',
                   fn.mort       = 'mort.B2007',
                   fn.recr       = 'recr.BBG2008',
                   fn.management = 'management.prob',
                   fn.tree.removal = 'mng.tree.removal',
                   fn.modif      = NULL,
                   fn.prep.common.vars = 'prep.common.vars.fun'
               ),
               n.periods = 5,
               period.length = 5,
               mng.options = NA,
               print.comments = FALSE,
               fn.dbh.inc = "dbhi.BN2009",
               fn.hgt.inc =  "height.korf",
               species.spruce = c(1, 2, 3),
               species.pine = c(10, 11, 20, 21, 29),
               species.harw = c(30, 31),
               fun.final.felling = "harv.prob",
               fun.thinning      = "thin.prob",
               'BN2009',
               'BBG2008', 'SBA.m2.ha', 'spp','pr.spru.ba', 'QMD.cm',
               per.vol.harv = 0.83
               )

spp <- sp.classification(tree.sp = tr$tree.sp,
                         species.spruce = c(1, 2, 3),
                         species.pine = c(10, 11, 20, 21, 29),
                         species.harw = c(30, 31)
                         )

biomass.kg <- biomass.M1988(res$live, spp , this.period = "t1")
```

---

biomass.Norway   *Biomass functions for Norway*

Description

Implements the currently used functions to estimate biomass in Norway.

Usage

```
biomass.Norway(tr, this.period)
```

Arguments

`tr`	A *trList* class object.
`this.period`	The period for which to calculate biomass.

Details

If *tr* is of class *trListDead* biomass is estimated for the last measurement. It uses *biomass.spruce.M1988*, *biomass.pine.M1988*, *biomass.birch.S2014*, *biomass.birch.M1988* (to add the stump to aboveground biomass and remove it from belowground biomass from biomass.birch.S2014 equations).

Value

Returns a list

`biomass.kg`	A data.frame with total biomass, biomass aboveground, biomass belowground, all in kg
`biomass.kg.components`	
	A data.frame with biomass components (see `biomass.birch.M1988`) in kg

Author(s)

Clara Anton Fernandez <caf@nibio.no>

References

Marklund, L. G. 1988. "Biomassafunktioner för tall, gran och björk i Sverige (Biomass functions for pine, spruce and birch in Sweden)." Report 45. Umeå, Sweden: Swedish University of Agricultural Sciences. Department of Forest Survey.

Petersson, Hans, and Göran Ståhl. 2006. "Functions for Below-Ground Biomass of Pinus Sylvestris, Picea Abies, Betula Pendula and Betula Pubescens in Sweden." Scandinavian Journal of Forest Research 21 (S7): 84–93. doi:10.1080/14004080500486864. Smith, Aaron, Aksel Granhus, and Rasmus Astrup. 2016. "Functions for Estimating Belowground and Whole Tree Biomass of Birch in Norway." Scandinavian Journal of Forest Research 31 (6): 568–82. Smith, Aaron, Aksel Granhus, Rasmus Astrup, Ole Martin Bollandsås, and Hans Petersson. 2014. "Functions for Estimating Aboveground Biomass of Birch in Norway." Scandinavian Journal of Forest Research 29 (6): 565–78.

See Also

`biomass.birch.S2014`, `biomass.birch.M1988`, `biomass.pine.M1988`, `biomass.spruce.M1988`

Examples

```
res <- sitree (tree.df   = tr,
               stand.df  = fl,
               functions = list(
                    fn.growth    = 'grow.dbhinc.hgtinc',
                    fn.mort      = 'mort.B2007',
                    fn.recr      = 'recr.BBG2008',
```

```
                             fn.management = 'management.prob',
                             fn.tree.removal = 'mng.tree.removal',
                             fn.modif       = NULL,
                             fn.prep.common.vars = 'prep.common.vars.fun'
                     ),
                     n.periods = 5,
                     period.length = 5,
                     mng.options = NA,
                     print.comments = FALSE,
                     fn.dbh.inc = "dbhi.BN2009",
                     fn.hgt.inc =  "height.korf",
                     species.spruce = c(1, 2, 3),
                     species.pine = c(10, 11, 20, 21, 29),
                     species.harw = c(30, 31),
                     fun.final.felling = "harv.prob",
                     fun.thinning      = "thin.prob",
                     'BN2009',
                     'BBG2008', 'SBA.m2.ha', 'spp','pr.spru.ba', 'QMD.cm',
                     per.vol.harv = 0.83
                     )
biomass.Norway (tr = res$live,
                this.period = "t1")
```

---

biomass.norway.sitree   *Calculates biomass for trees using the Norwegian biomass equations*

Description

Calculates biomass

Usage

```
biomass.norway.sitree(dbh.mm, height.dm, tree.sp)
```

Arguments

dbh.mm	Diameter at breast height in mm.
height.dm	Tree height in dm.
tree.sp	Tree species according to the Norwegian NFI. It will use biomass.spruce.M1988 when tree.sp is 1, 2, 3, 21, or 29, biomass.pine.M1988 when tree.sp is 10, 11, or 20, and biomass.birch.S2014 otherwise.

Value

Returns a data.table containing the 12 columns resulting from applying the biomass functions.

See Also

biomass.birch.S2014, biomass.pine.M1988, biomass.spruce.M1988

Examples

```
bio.nor <- biomass.norway.sitree (dbh.mm = c(50, 60, 100 ), height.dm = c(40, 60,
                                  80),
                      tree.sp = c(1, 10, 30))
```

---

biomass.sitree	*Biomass for live, dead, or removed trees using Norwegian biomass functions*

Description

Calculates biomass for trees using the Norwegian biomass equations.

Usage

```
biomass.sitree(tr, plot.data)
```

Arguments

tr	A trList or trListDead object.
plot.data	A data.frame or list with plot information. It should have at least plot.id and tree2ha.

Value

Returns a data.table containing the 12 columns resulting from applying the biomass functions.

Author(s)

Clara Anton Fernandez <caf@nibio.no>

See Also

biomass.birch.S2014, biomass.birch.M1988, biomass.pine.M1988, biomass.spruce.M1988, biomass.norway.sitree

Examples

```
##---- Should be DIRECTLY executable !! ----
##-- ==>  Define data, use random,
##--or do  help(data=index)  for the standard data sets.
result.sitree <- sitree (tree.df  = stand.west.tr,
                         stand.df  = stand.west.st,
                         functions = list(
                           fn.growth    = 'grow.dbhinc.hgtinc',
                           fn.mort      = 'mort.B2007',
                           fn.recr      = 'recr.BBG2008',
```

```
                                 fn.management = NULL,
                                 fn.tree.removal = NULL,
                                 fn.modif      = NULL,
                                 fn.prep.common.vars = 'prep.common.vars.fun'
                             ),
                             n.periods = 20,
                             period.length = 5,
                             mng.options = NA,
                             print.comments = FALSE,
                             fn.dbh.inc = "dbhi.BN2009",
                             fn.hgt.inc =  "height.korf",
                             species.spruce = c(1, 2, 3),
                             species.pine = c(10, 11, 20, 21, 29),
                             species.harw = c(30, 31),
                             'BN2009',
                             'BBG2008', 'SBA.m2.ha', 'spp','pr.spru.ba', 'QMD.cm'
                         )
## The function is currently defined as
biom <- biomass.sitree(tr = result.sitree$live, plot.data = result.sitree$plot.data)
biom
```

---

height.of.X.tallest.trees

Mean height of X tallest trees

Description

It calculates the mean height of the X tallest trees by grouping variable (e.g. the plot ID)

Usage

```
height.of.X.tallest.trees(height, uplotID, num.trees)
```

Arguments

height	A vector with heights
uplotID	A vector with the grouping variable, most often this would be the plot ID.
num.trees	Number of trees used to calculate the mean height.

Value

It returns a data.frame with two columns containing the uplotID and the mean height of the X tallest trees.

Note

This function can be used to calculate the average of the X largest values of any variable grouped by a grouping variable. It is mostly a wrapper for `aggregate`.

Author(s)

Clara Antón Fernández (caf@nibio.no)

See Also

[lorey.height](#)

Examples

```
height.of.X.tallest.trees(height = tr$height,
                               uplotID = tr$plot.id, 5)
```

---

lorey.height   *Lorey's height*

Description

Calculates Lorey's height (mean height weigted by basal area). If group.id is not NULL, it will calculate Lorey's height for each group.

Usage

```
lorey.height(BA, height, group.id = NULL)
```

Arguments

BA	A vector with the basal areas of the trees
height	A vector with the height of the trees
group.id	An optional vector with a grouping variable.

Value

If a grouping variable is provided it returns a data frame with two columns (group.id, and lorey.height). If a grouping variable is not provided it will return the Lorey's height.

Author(s)

Clara Anton Fernandez (caf@nibio.no)

See Also

[height.of.X.tallest.trees](#)

Examples

```
BA <- pi*(tr$dbh/2)^2
lorey.height(BA, tr$height)
lorey.height(BA, tr$height, tr$plot.id)
```

PBAL	*Basal area of larger trees*

Description

It calculates the basal area of larger trees for a plot.

Usage

```
PBAL(BA)
```

Arguments

BA   A vector of trees basal area

Value

It returns a vector with the sum of the basal areas of larger trees. Trees with similar BA are not considered larger.

Examples

```
PBAL(c(1,2,3,4,4))
```

PBAL.dbh.greater	*Basal area of larger trees which are at least X cm larger than the tree of interest*

Description

Calculates the basal area (in cm2 if dbh is in mm) of trees that are at least X (in the same units as dbh) larger than the tree of interest for a list of trees.

Usage

```
PBAL.dbh.greater(dbh.mm, dbh.mm.diff)
```

Arguments

dbh.mm   a vector of dbh in mm

dbh.mm.diff   minimum dbh difference between the tree and the tree of interest to be considered

Details

It estimates the basal area (in cm2) of trees that are at least dbh.mm.diff mm larger than the tree of interest.

Value

It returns a list with the basal area of larger trees.

Author(s)

Cara Antón-Fernández (email: caf@nibio.no)

See Also

PBAL

Examples

```
PBAL.dbh.greater(c(100,89,51,74,4), 3)

aggregate(dbh ~ plot.id, data = tr, FUN = PBAL.dbh.greater, dbh.mm.diff = 2)
```

---

picea.abies.vol　　　　　*Volumes for Norwegian species*

Description

These functions calculate tree volume with or without bark for the main species in Norway, that is, Norway spruce, Scots pine, Sitka spruce, birch, and ... following Braastad (1966), Brantseg (1967), and Vestjordet (1967).

Usage

```
picea.abies.vol(dbh, trh, bark, units)
picea.abies.volV(dbh, trh, bark, units)
pinus.sylvestris.vol(dbh, trh, bark, units)
pinus.sylvestris.volV(dbh, trh, bark, units)
sitka.vol(dbh, trh, bark, units)
harw.nor.vol(tsl, dbh, trh, bark, units)
```

Arguments

dbh	A vector with diameters at breast height in mm with bark.
trh	A vector with tree heights in cm.
bark	If tree volume should be calculated with bark, "mb", or wihtout bark, "ub".
units	"l" in liters, "c" in cubic centimeters.
tsl	Tree species 30 (), 31(), 32 (), 40(), 41(), 50(), NA. This only affects the calculations of diameter without bark.

Value

Returns tree volume in the selected units.

References

Braastad, H. 1966. Volumtabeller for bjoerk [Volume tables for birch]. Meddelelser fra Det norske
Skogforsøksvesen 21: 23–78. Brantseg, A. 1967. Furu sønnafjells. Kubering av staaende skog.
Funksjoner og tabeller [Volume functions and tables for Scots pine. South Norway]. Meddelelser
fra Det norske Skogforsøksvesen 22: 695–739. Vestjordet, E. 1967. Funksjoner og tabeller for
kubering av staaende gran [Functions and tables for volume of standing trees. Norway spruce].
Meddelelser fra Det norske Skogforsøksvesen 22. Ås, Norway: Norwegian Forest and Landscape
Institute.

Examples

```
harw.nor.vol(tsl = c(30,31), dbh = c(45, 25), trh = c(120, 80), bark = "ub", units = "l")
```

PlotDataToLong   *Convert Plot data to a data.frame/data.table format*

Description

It attemps to convert the plot level information to a data.frame/data.list format. For example, if
management is an element of the plot list (pd) it will melt it to a long format.

Usage

```
PlotDataToLong(pd)
```

Arguments

pd   A list with plot information. It especifically looks for two elements 'stand.age.years'
                 and 'management'.

Value

It returns a data.table with all vector from pd as columns, and dataframes melted.

Examples

```
result.sitree <- sitree (tree.df   = tr,stand.df  = fl,
functions = list(fn.growth     ='grow.dbhinc.hgtinc',
fn.mort       ='mort.B2007',
fn.recr       ='recr.BBG2008',
fn.management ='management.prob',
fn.tree.removal ='mng.tree.removal',
fn.modif      = NULL,
fn.prep.common.vars ='prep.common.vars.fun'),
```

```
n.periods = 5,
period.length = 5,mng.options = NA,
print.comments = FALSE,
fn.dbh.inc = "dbhi.BN2009",
fn.hgt.inc =  "height.korf",
species.spruce = c(1, 2, 3),
species.pine = c(10, 11, 20, 21, 29),species.harw = c(30, 31),
fun.final.felling = "harv.prob",fun.thinning     =
"thin.prob",'BN2009','BBG2008',
'SBA.m2.ha','spp','pr.spru.ba','QMD.cm',per.vol.harv = 0.83)

PlotDataToLong(result.sitree$plot.data)
```

---

top.height	*Top height of the n thickest trees*

Description

Average height of the n thickest trees per ha

Usage

```
top.height(thickness, height, num.trees.per.ha, plot.id, plot.size.m2)
```

Arguments

thickness	A vector with the thickness for every tree. Other variables can be used instead to thickness. This is only used to order the trees.
height	Height of the trees.
num.trees.per.ha	
	Number of trees per ha that the top height should correspond to. E.g. 100 trees per ha.
plot.id	Vector with the plot.id to which every tree corresponds to.
plot.size.m2	Plot size in square meters. It can be either a single number if all plots have the same size of a vector of equal length as thickness, height, and plot.id with the corresponding plot size for each tree.

Details

thickness, height, and plot.id should have the same length, that is, one value per tree.

Value

It returns a data.frame with two columns: top.heights in the same units as height, and plot.id.

Examples

```
top.height(thickness = runif(100, 10,40), height = runif(100, 12, 45),
    num.trees.per.ha = 100, plot.id = 1, plot.size.m2 = 250)
```

---

volume.norway	*Tree volume for Norwegian conditions*

Description

Calculates tree volume following the equations used in the Norwegian national forest inventory

Usage

```
volume.norway(dbh.mm, height.dm, tree.sp, kom, vol.reduksjon = NULL,
vol.w = TRUE, vol.wo = TRUE)
```

Arguments

dbh.mm	tree dbh in mm
height.dm	tree height in dm
tree.sp	tree species following the same codification as the Norwegian NFI
kom	municipality code
vol.reduksjon	volume reduction in 100
vol.w	TRUE/FALSE if volume with bark needs to be calculated
vol.wo	TRUE/FALSE if volume without bark needs to be calculated

Value

It returns a list with up to two elements:

vol.w.tr.m3	volume with bark per tree in m3
vol.wo.tr.m3	volume without bark per tree in m3

See Also

volume.sitree [volume.sitree](#)

Examples

```
volume.norway(dbh.mm = c(50,70), height.dm = c(17,20), tree.sp = c(1, 10), kom = c(623, 623))
```

---

volume.sitree   *Volume for sitree output for Norwegian conditions*

Description

It calculates volume following the Norwegian national forest inventory equations for a trList or trListDead object

Usage

```
volume.sitree(tr, plot.data)
```

Arguments

tr   a trListDead or trList object

plot.data   a list or data.frame containing at least a 'kom' and 'tree2ha' column/element.
                  kom is the kommune (municipality) code, and tree2ha should be the expansion
                  factor to go from tree to per ha basis.

Details

It uses the volume.norway function to estimate the volume for all trees with dbh.mm greater than 0. It returns NA when dbh.mm is 0 or lower. tree2ha is included to facilitate the calculation of per ha values.

Value

It returns a data.table with columns for treeid, plot.id, dbh.mm, height.dm, kom, tree2ha, tree.sp, vol.w.tr.m3 (volume with bark in m3 per tree), and vol.wo.tr.m3 (volume without bark in m3 per tree)

Author(s)

Clara Anton Fernandez

Examples

```
res <- sitree (tree.df  = tr,
               stand.df  = fl,
               functions = list(
                   fn.growth      = 'grow.dbhinc.hgtinc',
                   fn.mort        = 'mort.B2007',
                   fn.recr        = 'recr.BBG2008',
                   fn.management  = 'management.prob',
                   fn.tree.removal = 'mng.tree.removal',
                   fn.modif       = NULL,
                   fn.prep.common.vars = 'prep.common.vars.fun'
               ),
```

```
                 n.periods = 5,
                 period.length = 5,
                 mng.options = NA,
                 print.comments = FALSE,
                 fn.dbh.inc = "dbhi.BN2009",
                 fn.hgt.inc =  "height.korf",
                 species.spruce = c(1, 2, 3),
                 species.pine = c(10, 11, 20, 21, 29),
                 species.harw = c(30, 31),
                 fun.final.felling = "harv.prob",
                 fun.thinning     = "thin.prob",
                 'BN2009',
                 'BBG2008', 'SBA.m2.ha', 'spp','pr.spru.ba', 'QMD.cm',
                 per.vol.harv = 0.83
                 )
volume.sitree(tr = res$live, plot.data = res$plot.data)
```

Index