Package: r3PG (via r-universe)

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Type Package

Title Simulating Forest Growth using the 3-PG Model

Description Provides a flexible and easy-to-use interface for the Physiological Processes Predicting Growth (3-PG) model written in Fortran. The r3PG serves as a flexible and easy-to-use interface for the 3-PGpjs (monospecific, evenaged and evergreen forests) described in Landsberg & Waring (1997) <doi:10.1016/S0378-1127(97)00026-1> and the 3-PGmix (deciduous, uneven-aged or mixed-species forests) described in Forrester & Tang (2016) <doi:10.1016/j.ecolmodel.2015.07.010>.

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`d_climate` *Climate input*

Description

Table containing the information about monthly values for climatic data.

Usage

```
d_climate
```

Format

A data frame with 156 rows and 7 variables:

year calendar year

month month

tmp_min monthly mean daily minimum temperature (C)

tmp_max monthly mean daily maximum temperature (C)

tmp_ave monthly mean daily average temperature (C). (optional)

prcp monthly rainfall (mm month-1)

srad monthly mean daily solar radiation (MJ m-2 d-1)

frost_days frost days per month (d month-1)

co2 monthly mean atmospheric co2 (ppm), required if calculate_d13c=1 (optional)

d13catm Monthly mean isotopic composition of air (‰), required if calculate_d13c=1 (optional)

---

d_parameters *Parameters input*

Description

Table containing the information about parameters.

Usage

```
d_parameters
```

Format

A data frame with 65 rows and x variables:

parameter name of the parameter, must be consistent in naming with i_parameters

Fagus sylvatica parameter values for species 1

Pinus sylvestris parameter values for species 2

d_site *Site input*

Description

Table containing the information about site conditions.

Usage

```
d_site
```

Format

A `data frame` with 1 rows and 8 variables:

latitude site latitude in the WGS84 coordinate system

altitude site altitude, m a.s.l.

soil_class soil class, according to table 2 user manual of 3PGpjs. 1 - Sandy; 2 - Sandy loam; 3 - Clay loam; 4 - Clay; 0 - No effect of available soil water on production

asw_i initial available soil water (mm)

asw_max minimum available soil water (mm)

asw_min maximum available soil water (mm)

from year and month indicating the start of simulation. Provided in form of year-month. E.g. "2000-01"

to year and month indicating the end of simulation. Provided in form of year-month. E.g. "2009-12", will include December 2009 as last simulation month

d_sizeDist *sizeDist input*

Description

Table containing the information about size distribution.

Usage

```
d_sizeDist
```

Format

A data frame with 47 rows and x variables:

parameter name of the parameter, must be consistent in naming with `i_sizeDist`

Fagus sylvatica parameter values for species 1

Pinus sylvestris parameter values for species 2

d_species *Species input*

Description

Table containing the information about species level data. Each row corresponds to one species/cohort.

Usage

```
d_species
```

Format

A `data frame` with number of rows corresponding to each species/cohort and 8 variables:

species species or cohort id/name. It must be consistent with species names in `d_thinning`, `d_parameters` and `d_sizeDist` tables.

planted year and month indicating when the species was planted. Provided in form of year-month. E.g. "2000-01"

fertility soil fertility for a given species. Range from 0 to 1

stems_n number of trees per ha

biom_stem stem biomass for a given species (Mg/ha)

biom_root root biomass for a given species (Mg/ha)

biom_foliage initial foliage biomass (Mg/ha). If this is a leafless period, provide the spring foliage biomass.

d_thinning *Thinning input*

Description

Table containing the information about thinnings

Usage

```
d_thinning
```

Format

A data frame with 3 rows and 6 variables:

species species or cohort id/name. It must be consistent with species names in d_species, d_parameters and d_sizeDist tables.

age age when thinning is performed

stems_n number of trees remaining after thinning

stem type of thinning (above/below). Default is 1

root type of thinning (above/below). Default is 1

foliage type of thinning (above/below). Default is 1

---

get_parameters *Get parameter sets*

Description

Gets parameter sets from published studies with 3PG

Usage

```
get_parameters(mode = "overview", sp_names = NULL)
```

Arguments

mode	must be one of the following: full, overview, source, comments, parameters, sizeDist
sp_names	names of the species. The 'sp_names' must be either a scientific name (Picea abies). If passing parameters or sizeDist to mode, it also possible to use a scientific name with a integer, which is the value of parset_id, e.g. Picea abies 37. If unsure, consider using first the option mode = overview with sp_names = NULL. See details below for more information.

Details

This function access the parameter database stored in the package, which is named i_parameters_lit, and also accessible without this function. If mode = overview, a simplified table with all existing parameter sets will be returned. A extended version including information about to the source and remarks can be obtained with mode = comments. A complete description of the source is returned with mode = source. The full version of this table (species,source, comments, parameters) will be returned if mode = full. Alternatively, with mode = parameters and mode = sizeDist, it is possible to obtain parameters in the format required by run_3PG.

Passing species names with sp_names will selecting from the table the desired species. Please note that one species might have more than one available parameter sets, unless species names contain the parset_id value. Please also note that mode = source is not compatible with sp_names.

The parameter sets were obtained from published studies. For basic information about this dataset check in i_parameters_lit. Relevant information about the parameter sets and the corresponding studies is provided in the table. For further information, please consider checking the original publications.

Value

a data frame with parameter sets for all available species, or only the requested species, if sp_names is not null.

See Also

run_3PG, i_parameters_lit

Examples

```
# see an overview of the existing parameter sets
get_parameters(mode = 'overview')
get_parameters(mode = 'overview', sp_names = c('Eucalyptus globulus', 'Pinus sylvestris' ) )

# see existing parameter sets and comments
get_parameters(mode = 'comments')
get_parameters(mode = 'comments', sp_names = c('Eucalyptus globulus', 'Pinus sylvestris' ) )

# see parameters and source information
get_parameters(mode = 'source')

# obtain parameter sets in for some species in the format required by run_3PG
get_parameters(mode = 'parameters', sp_names = c('Fagus sylvatica', 'Picea abies'))
get_parameters(mode = 'parameters', sp_names = 'Fagus sylvatica 34' )
get_parameters(mode = 'sizeDist', sp_names = c('Fagus sylvatica 9', 'Picea abies 37'))

# see parameter sets with full information (species, source, parameters)
get_parameters(mode = 'full')
get_parameters(mode = 'full', sp_names = c('Fagus sylvatica', 'Pinus radiata' ) )
```

---

i_output *Information about model outputs*

Description

A dataset containing the list of output variables and their description.

Usage

```
i_output
```

Format

A data frame with 150 rows and 7 variables:

group_id serial number of the group

variable_id serial number of the variable

variable_group group name to which variable belongs

variable_name variable name as named in output

description description of the variable

unit unit of the variable

variable_vba corresponding name of the variable as output from Excel version of 3-PGmix

---

`i_parameters` *Information about parameters*

Description

A dataset containing the parameters order and description.

Usage

```
i_parameters
```

Format

A data frame with 82 rows and 3 variables:

parameter parameter name

description description of the parameter

unit unit

default default value for E.globulus from original 3-PG

`i_parameters_lit` *Information about literature parameters*

Description

A dataset containing parameter sets from published studies with 3PG

Usage

```
i_parameters_lit
```

Format

A data frame with 110 rows and 124 variables:

parset_id id of the parameter set

species species scientific name

age whether the parameter set was was used in even or uneven stands.

type whether the parameter set was used in monocultures or mixed stands.

year year of publication

region geographical region in which the parameters were tested. NAs values are allowed.

country country or countries in which the parameters were tested.

notes any relevant remark about how the parameters were processed. NAs are allowed.

source short reference to publication

source_comments any relevant comment about the parameters present in the publication. NAs are allowed.

source_full full reference to publication

link a link to the publication, e.g. doi

pFS2 Foliage:stem partitioning ratio - D = 2 cm

pFS20 Foliage:stem partitioning ratio - D = 20 cm

aWS Constant in the stem mass v. diam. relationship

nWS Power in the stem mass v. diam. relationship

pRx Maximum fraction of NPP to roots

pRn Minimum fraction of NPP to roots

gammaF1 Maximum litterfall rate

gammaF0 Litterfall rate at t = 0

tgammaF Age at which litterfall rate has median value

gammaR Average monthly root turnover rate

leafgrow If deciduous, leaves are produced at end of this month

leaffall If deciduous, leaves all fall at start of this month

Tmin Minimum temperature for growth

Topt Optimum temperature for growth

Tmax Maximum temperature for growth

kF Days production lost per frost day

SWconst Moisture ratio deficit for fq = 0.5

SWpower Power of moisture ratio deficit

fCalpha700 Assimilation enhancement factor at 700 ppm

fCg700 Canopy conductance enhancement factor at 700 ppm

m0 Value of m when FR = 0

fN0 Value of fNutr when FR = 0

fNn Power of (1-FR) in fNutr

MaxAge Maximum stand age used in age modifier

nAge Power of relative age in function for fAge

rAge Relative age to give fAge = 0.5

gammaN1 Mortality rate for large t

gammaN0 Seedling mortality rate (t = 0)

tgammaN Age at which mortality rate has median value

ngammaN Shape of mortality response

wSx1000 Max. stem mass per tree - 1000 trees/hectare

thinPower Power in self-thinning rule

mF Fraction mean single-tree foliage biomass lost per dead tree

mR Fraction mean single-tree root biomass lost per dead tree

mS Fraction mean single-tree stem biomass lost per dead tree

SLA0 Specific leaf area at age 0

SLA1 Specific leaf area for mature leaves

tSLA Age at which specific leaf area = (SLA0+SLA1)/2

k Extinction coefficient for absorption of PAR by canopy

fullCanAge Age at canopy closure

MaxIntcptn Maximum proportion of rainfall evaporated from canopy

LAImaxIntcptn LAI for maximum rainfall interception

cVPD LAI for 50% reduction of VPD in canopy

alphaCx Canopy quantum efficiency

Y Ratio NPP/GPP

MinCond Minimum canopy conductance

MaxCond Maximum canopy conductance

LAIgcx LAI for maximum canopy conductance

CoeffCond Defines stomatal response to VPD

BLcond Canopy boundary layer conductance

RGcGw The ratio of diffusivities of CO2 and water vapour in air

D13CTissueDif d13C difference of modelled tissue and new photosynthate

aFracDiffu Fractionation against 13C in diffusion

bFracRubi Enzymatic fractionation by Rubisco

fracBB0 Branch and bark fraction at age 0

fracBB1 Branch and bark fraction for mature stands

tBB Age at which fracBB = (fracBB0+fracBB1)/2

rhoMin Minimum basic density - for young trees

rhoMax Maximum basic density - for older trees

tRho Age at which rho = (rhoMin+rhoMax)/2

aH Constant in the stem height relationship

nHB Power of DBH in the stem height relationship

nHC Power of competition in the stem height relationship

aV Constant in the stem volume relationship

nVB Power of DBH in the stem volume relationship

nVH Power of height in the stem volume relationship

nVBH Power of DBH^2 x height in the stem volume relationship

crownshape Crown shape (1=cone, 2=ellipsoid, 3=half-ellipsoid, 4=rectangular)

aK Constant in the crown diameter relationship

nKB Power of DBH in the crown diameter relationship

nKH Power of height in the crown diameter relationship

nKC Power of competition in the crown diameter relationship

nKrh Power of relative height in the crown diameter relationship

aHL Constant in the LCL relationship

nHLB Power of DBH in the LCL relationship

nHLL Power of LAI in the LCL relationship

nHLC Power of competition in the LCL relationship

nHLrh Power of relative height in the LCL relationship

Dscale0 Constant in the relationship for Weibull scale parameter of D distribution

DscaleB Slope of DBH in relationship for Weibull scale parameter of D distribution

Dscalerh Slope of relative height in relationship for Weibull scale parameter of D distribution

Dscalet Slope of age in relationship for Weibull scale parameter of D distribution

DscaleC Slope of competition in relationship for Weibull scale parameter of D distribution

Dshape0 Constant in the relationship for Weibull shape parameter of D distribution

DshapeB Slope of DBH in relationship for Weibull shape parameter of D distribution

Dshaperh Slope of relative height in relationship for Weibull shape parameter of D distribution

Dshapet Slope of age in relationship for Weibull shape parameter of D distribution

DshapeC Slope of competition in relationship for Weibull shape parameter of D distribution

Dlocation0 Constant in the relationship for Weibull location parameter of D distribution

DlocationB Slope of DBH in relationship for Weibull location parameter of D distribution

Dlocationrh Slope of relative height in relationship for Weibull location parameter of D distribution

Dlocationt Slope of age in relationship for Weibull location parameter of D distribution

DlocationC Slope of competition in relationship for Weibull location parameter of D distribution

wsscale0 Constant in the relationship for Weibull scale parameter of ws distribution

wsscaleB Slope of DBH in relationship for Weibull scale parameter of ws distribution

wsscalerh Slope of relative height in relationship for Weibull scale parameter of ws distribution

wsscalet Slope of age in relationship for Weibull scale parameter of ws distribution

wsscaleC Slope of competition in relationship for Weibull scale parameter of ws distribution

wsshape0 Constant in the relationship for Weibull shape parameter of ws distribution

wsshapeB Slope of DBH in relationship for Weibull shape parameter of ws distribution

wsshaperh Slope of relative height in relationship for Weibull shape parameter of ws distribution

wsshapet Slope of age in relationship for Weibull shape parameter of ws distribution

wsshapeC Slope of competition in relationship for Weibull shape parameter of ws distribution

wslocation0 Constant in the relationship for Weibull location parameter of ws distribution

wslocationB Slope of DBH in relationship for Weibull location parameter of ws distribution

wslocationrh Slope of relative height in relationship for Weibull location parameter of ws distribution

wslocationt Slope of age in relationship for Weibull location parameter of ws distribution

wslocationC Slope of competition in relationship for Weibull location parameter of ws distribution

Qa Intercept of net v. solar radiation relationship

Qb Slope of net v. solar radiation relationship

gDM_mol Molecular weight of dry matter

molPAR_MJ Conversion of solar radiation to PAR

Details

Each row refers to an unique parameter set. The function `get_parameters` eases the use to this dataset.

i_sizeDist *Information about size distribution parameters*

Description

A dataset containing the parameters order and description.

Usage

```
i_sizeDist
```

Format

A data frame with 30 rows and 3 variables:

parameter parameter name

description description of the parameter

unit unit

default default value equal to 0

prepare_climate *Subsets or replicate a climate data*

Description

Prepares the climate table, by either replicating the average climate for the required number of years, or by sub-setting from a longer time-series of climate data.

Usage

```
prepare_climate(climate, from = "2000-04", to = "2010-11")
```

Arguments

climate	table containing the information about monthly values for climatic data. If the climate table have exactly 12 rows it will be replicated for the number of years and months specified by `from` - `to`. Otherwise, it will be subsetted to the selected time period. If this is required, `year` and `month` columns must be included in the climate table. The minimum required columns are listed below, but additionally you can include: tmp_ave, c02, d13catm. Please refer to `d_climate` for example. • year: year of observation (only required for subsetting) (numeric). • month: months of observation (only required for subsetting) (numeric). • tmp_min: monthly mean daily minimum temperature (C).

- tmp_max: monthly mean daily maximum temperature (C).
- tmp_ave: monthly mean daily average temperature (C) (optional).
- prcp: monthly rainfall (mm month-1).
- srad: monthly mean daily solar radiation (MJ m-2 d-1).
- frost_days: frost days per month (d month-1).
- co2: monthly mean atmospheric co2 (ppm), required if calculate_d13c=1 (optional).
- d13catm: monthly mean isotopic composition of air (‰), required if calculate_d13c=1 (optional).

`from` year and month indicating the start of simulation. Provided in form of year-month. E.g. "2000-01".

`to` year and month indicating the end of simulation. Provided in form of year-month. E.g. "2009-12", will include December 2009 as last simulation month.

Details

This function prepares the climate table for `run_3PG`.

In case a user provides only average climate, this is replicated for the desired simulation period.

In case a larger climate file is provided, the simulation period is selected from this.

Value

a data.frame with number of rows corresponding to number of simulated month and 10 columns

See Also

`run_3PG`, `prepare_input`, `prepare_parameters`, `prepare_sizeDist`, `prepare_thinning`

Examples

```
# sub-setting climate data
prepare_climate( climate = d_climate, from = '2003-04', to = '2010-11')

# replicating climate data
set.seed(1)
climate = data.frame( tmp_min = rnorm(12, mean = 10),
                      tmp_max = rnorm(12, mean = 20),
                      prcp = sample(c(0:200), 12),
                      srad = sample(c(1:100), 12),
                      frost_days = sample(c(0:30), 12))

prepare_climate( climate = climate, from = '2000-04', to = '2010-11')
```

prepare_input *Check and prepare input for running 3-PG model*

Description

Checks and prepares all input tables to be used in run_3PG. For detailed descriptions see Forrester (2020).

Usage

```
prepare_input(site, species, climate, thinning = NULL, parameters = NULL,
  size_dist = NULL, settings = NULL)
```

Arguments

`site` table containing the information about site conditions.

- latitude: site latitude in the WGS84 coordinate system.
- altitude: site altitude, m a.s.l.
- soil_class: 1 - Sandy; 2 - Sandy loam; 3 - Clay loam; 4 - Clay; 0 - No effect of asw on production.
- asw_i: initial available soil water (mm).
- asw_min: minimum available soil water (mm).
- asw_max: maximum available soil water (mm).
- from: year and month indicating the start of simulation. Provided in form of year-month. E.g. "2000-01".
- to: year and month indicating the end of simulation. Provided in form of year-month. E.g. "2009-12", will include December 2009 as last simulation month

`species` table containing the information about species level data. Each row corresponds to one species/cohort.

- species: species or cohort id/name. It must be consistent with species names in `thinning`, `parameters` and `sizeDist` tables.
- planted: year and month indicating when species was planted. Provided in form of year-month. E.g. "2000-01".
- fertility: soil fertility for a given species. Range from 0 to 1.
- stems_n: number of trees per ha.
- biom_stem: stem biomass for a given species (Mg/ha).
- biom_root: root biomass for a given species (Mg/ha).
- biom_foliage: initial foliage biomass (Mg/ha). If this is a leafless period, provide the spring foliage biomass.

`climate` table containing the information about monthly values for climatic data. If the climate table has exactly 12 rows it will be replicated for the number of years and months specified by `from` - `to`. Otherwise, it will be subsetted to the selected time period. More details about preparing climate data are at `prepare_climate`.

- year: year of observation (only required for subsetting) (optional).
- month: months of observation (only required for subsetting) (optional).
- tmp_min: monthly mean daily minimum temperature (C).
- tmp_max: monthly mean daily maximum temperature (C).
- tmp_ave: monthly mean daily average temperature (C) (optional).
- prcp: monthly rainfall (mm month-1).
- srad: monthly mean daily solar radiation (MJ m-2 d-1).
- frost_days: frost days per month (d month-1).
- vpd_day: water pressure deficit (mbar) (optional).
- co2: monthly mean atmospheric co2 (ppm), required if calculate_d13c=1 (optional)
- d13catm: monthly mean isotopic composition of air (‰), required if calculate_d13c=1 (optional)

`thinning` table containing the information about thinnings. If there is no thinning, it must be `NULL`.

- species: species or cohort id/name. It must be consistent with species names in `species`, `parameters` and `sizeDist` tables.
- age: age when thinning is performed.
- stems_n: number of trees remaining after thinning
- foliage: type of thinning (above/below). Default is 1.
- root: type of thinning (above/below). Default is 1.
- stem: type of thinning (above/below). Default is 1.

`parameters` table containing the information about parameters to be modified. Values that are not provided are replaced by defaults.

- parameter: name of the parameter, must be consistent in naming with `i_parameters`
- species: each column must correspond to species/cohort id/name, as defined in `species` table

`size_dist` table containing the information about size distribution to be modified. Values that are not provided are replaced by defaults.

- parameter: name of the parameter, must be consistent in naming with `i_sizeDist`
- species: each column must correspond to species/cohort id/name, as defined in `species` table

`settings` a list with settings for the model. Values that are not provided are replaced by defaults.

- light_model: '1' - 3-PGpjs (default); '2' - 3-PGmix
- transp_model: '1' - 3-PGpjs (default); '2' - 3-PGmix
- phys_model: '1' - 3-PGpjs (default); '2' - 3-PGmix
- height_model: '1' - linear (default); '2' - non-linear
- correct_bias: '0' - no (default); '1' - yes
- calculate_d13c: '0' - no (default); '1' - yes

Details

This function checks and prepares the input data for the `run_3PG`. The output is a list with 7 tables. Each of them corresponds to the one from input.

Value

a list with seven tables. Each table corresponds to one of the input tables.

References

Forrester, D. I., 2020. 3-PG User Manual. Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf, Switzerland. 70 p. Available at the following web site: http://sites.google.com/site/davidforresterssite/home/projects/3PGmix/3pgmixdownload

Sands, P. J., 2010. 3PGpjs user manual. Available at the following web site: https://3pg.sites.olt.ubc.ca/files/2014/04/3PGpjs_UserManual.pdf

See Also

run_3PG, prepare_parameters, prepare_sizeDist, prepare_thinning, prepare_climate, prepare_site

Examples

```
prepare_input( site = d_site, species = d_species, climate = d_climate, d_thinning)
```

---

prepare_parameters *Prepare parameters table*

Description

Prepares the parameters table, by either replicating the defaults or replicating defaults for each of the species.

Usage

```
prepare_parameters(parameters = NULL, sp_names = c("Fagus sylvatica",
  "Pinus sylvestris"))
```

Arguments

parameters	table containing the information about parameters to be modified. Values that are not provided are replaced by defaults. • parameter: name of the parameter, must be consistent in naming with i_parameters • species: each column must correspond to species/cohort id/name, as defined in species table
sp_names	names of the species / cohorts used for the simulations.The 'sp_names' must be identical to those from species table.

Details

This function prepares the parameter table for run_3PG

Value

a data.frame with 47 rows and columns corresponding to each species.

See Also

run_3PG, prepare_input, prepare_sizeDist, prepare_thinning, prepare_climate

Examples

```
# replace some
prepare_parameters( parameters = d_parameters[1:4,],
  sp_names = c('Fagus sylvatica', 'Pinus sylvestris' ))

# Make default
prepare_parameters( parameters = NULL, sp_names = c('Quercus', 'Abies'))
```

---

prepare_site *Check the site data for consistency*

Description

Prepares the site table, by checking whether the input information is consistent.

Usage

```
prepare_site(site)
```

Arguments

site	table containing the information about site data. It shall contain exactly one row. • latitude: site latitude in the WGS84 coordinate system. • altitude: site altitude, m a.s.l. • soil_class: soil class, according to table 2 user manual of 3PGpjs. 1 - Sandy; 2 - Sandy loam; 3 - Clay loam; 4 - Clay; 0 - No effect of available soil water on production. • asw_i: initial available soil water (mm). • asw_max: minimum available soil water (mm). • asw_min: maximum available soil water (mm). • from: year and month indicating the start of simulation. Provided in form of year-month. E.g. "2000-01". • to: year and month indicating the end of simulation. Provided in form of year-month. E.g. "2009-12", will include December 2009 as last simulation month.

Details

This function check the site table for run_3PG.

Value

a data.frame with one row

See Also

run_3PG, prepare_input, prepare_parameters, prepare_sizeDist, prepare_thinning

Examples

```
# check site data
prepare_site( site = d_site)
```

---

prepare_sizeDist *Prepare parameters table*

Description

Prepares the parameters table, by either replicating the defaults or replicating defaults for each of the species.

Usage

```
prepare_sizeDist(size_dist = NULL, sp_names = c("Fagus sylvatica",
  "Pinus sylvestris"))
```

Arguments

size_dist	table containing the information about size distribution to be modified. Values that are not provided are replaced by defaults. • parameter: name of the parameter, must be consistent in naming with i_sizeDist. • species: each column must correspond to species/cohort id/name, as defined in species table.
sp_names	names of the species / cohorts used for the simulations.The 'sp_names' must be identical to those from species table.

Details

This function prepares the parameter table for run_3PG.

Value

a data.frame with 47 rows and columns corresponding to each species.

See Also

run_3PG, prepare_input, prepare_parameters, prepare_thinning, prepare_climate

Examples

```
# replace some
prepare_sizeDist( size_dist = d_sizeDist[1:4,],
  sp_names = c('Fagus sylvatica', 'Pinus sylvestris' ))

# Make default
prepare_sizeDist( size_dist = NULL, sp_names = c('Quercus', 'Abies'))
```

---

prepare_species *Check the species data for consistency*

Description

Prepares the species table, by checking whether the input information is consistent.

Usage

```
prepare_species(species)
```

Arguments

species	table containing the information about species level data. Each row corresponds to one species/cohort. • species: species or cohort id/name. It must be consistent with species names in thinning, parameters and sizeDist tables. • planted: year and month indicating when species was planted. Provided in form of year-month. E.g. "2000-01". • fertility: soil fertility for a given species. Range from 0 to 1. • stems_n: number of trees per ha. • biom_stem: stem biomass for a given species (Mg/ha). • biom_root: root biomass for a given species (Mg/ha). • biom_foliage: initial foliage biomass (Mg/ha). If this is a leafless period, provide the spring foliage biomass.

Details

This function check the species table for run_3PG.

Value

a data.frame with one row

See Also

run_3PG, prepare_input, prepare_parameters, prepare_sizeDist, prepare_thinning, prepare_site

Examples

```
# check species data
prepare_species( species = d_species)
```

---

prepare_thinning *Check and prepare management information.*

Description

Prepares the management table and checks for consistency.

Usage

```
prepare_thinning(thinning = NULL, sp_names = c("Fagus sylvatica",
  "Pinus sylvestris"))
```

Arguments

thinning	table containing the information about thinnings. If there is no thinning, it must be NULL. The following columns are required: • species: species or cohort id/name. • age: age at which thinning is done. • stems_n: number of trees remaining after thinning • stem: type of thinning (above/below). Default is 1. • foliage: type of thinning (above/below). Default is 1. • root: type of thinning (above/below). Default is 1.
sp_names	names of the species / cohorts used for the simulations. This is required whether 'thinning=NULL' or if not all species are indicated in the 'thinning' table. The 'sp_names' must be identical to those from species table.

Details

This function prepares the thinning table for run_3PG.

In case there is no thinning it will return empty 3-d array.

In case there will be thinning it will return 3-d array, where one dimension correspond to each species.

Value

a 3-dimentional array, where third dimention correspond to each species.

See Also

run_3PG, prepare_input, prepare_parameters, prepare_sizeDist, prepare_climate

Examples

```
prepare_thinning( thinning = NULL, sp_names = c('Quercus', 'Abies'))

prepare_thinning( thinning = d_thinning, sp_names = c('Fagus sylvatica', 'Pinus sylvestris'))
```

---

r3PG *Simulating Forest Growth using the 3-PG Process-Based Vegetation Model*

Description

The r3PG package provides a flexible and easy-to-use interface for Fortran implementations of the 3-PGpjs (monospecific, evenaged and evergreen forests) or 3-PGmix (deciduous, uneven-aged or mixed-species forests) forest growth models. The user can flexibly switch between various options and submodules, to use the original 3-PGpjs model version for monospecific, even-aged and evergreen forests and the 3-PGmix model, which can also simulate multi-cohort stands (e.g. mixtures, uneven-aged) that contain deciduous species. The core function to run the model is run_3PG. For more background, please consult the vignette via vignette(package = "r3PG")

Value

None

References

Forrester, D. I., 2020. 3-PG User Manual. Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf, Switzerland. 70 p. Available at the following web site: http://sites.google.com/site/davidforresterssite/home/projects/3PGmix/3pgmixdownload

Forrester, D. I., & Tang, X. (2016). Analysing the spatial and temporal dynamics of species interactions in mixed-species forests and the effects of stand density using the 3-PG model. Ecological Modelling, 319, 233–254. doi:10.1016/j.ecolmodel.2015.07.010

Landsberg, J. J., & Waring, R. H., 1997. A generalised model of forest productivity using simplified concepts of radiation-use efficiency, carbon balance and partitioning. Forest Ecology and Management, 95(3), 209–228. doi:10.1016/S03781127(97)000261

Sands, P. J., 2010. 3PGpjs user manual. Available at the following web site: https://3pg.sites.olt.ubc.ca/files/2014/04/3PGpjs_UserManual.pdf

See Also

run_3PG

Examples

```
out <- run_3PG(
  site = d_site,
  species = d_species,
  climate = d_climate,
  thinning = d_thinning,
  parameters = d_parameters,
  size_dist = d_sizeDist,
  settings = list(light_model = 2, transp_model = 2, phys_model = 2,
                  correct_bias = 1, calculate_d13c = 0),
  check_input = TRUE, df_out = TRUE) # note that default is TRUE

str(out) # List output format
```

---

run_3PG *Runs a 3-PG model simulation*

Description

Runs the 3-PGpjs (monospecific, evenaged and evergreen forests) or 3-PGmix (deciduous, unevenaged or mixed-species forests) model. For more details on parameters and structure of input visit prepare_input.

Usage

```
run_3PG(site, species, climate, thinning = NULL, parameters = NULL,
  size_dist = NULL, settings = NULL, check_input = TRUE, df_out = TRUE)
```

Arguments

site	table as described in prepare_input containing the information about site conditions.
species	table as described in prepare_input containing the information about species level data. Each row corresponds to one species/cohort.
climate	table as described in prepare_input containing the information about monthly values for climatic data. See also prepare_climate
thinning	table as described in prepare_input containing the information about thinnings. See also prepare_thinning
parameters	table as described in prepare_input containing the information about parameters to be modified. See also prepare_parameters
size_dist	table as described in prepare_input containing the information about size distributions. See also prepare_sizeDist
settings	a list as described in prepare_input with settings for the model.
check_input	logical if the input shall be checked for consistency. It will call prepare_input function.
df_out	logical if the output shall be long data.frame (TRUE) the 4-dimensional array (FALSE).

Details

'r3PG' provides an implementation of the Physiological Processes Predicting Growth 3-PG model, which simulates forest growth and productivity. The 'r3PG' serves as a flexible and easy-to-use interface for the '3-PGpjs' (monospecific, evenaged and evergreen forests) and the '3-PGmix' (deciduous, uneven-aged or mixed-species forests) model written in 'Fortran'. The package, allows for fast and easy interaction with the model, and 'Fortran' re-implementation facilitates computationally intensive sensitivity analysis and calibration. The user can flexibly switch between various options and submodules, to use the original '3-PGpjs' model version for monospecific, even-aged and evergreen forests and the '3-PGmix' model, which can also simulate multi-cohort stands (e.g. mixtures, uneven-aged) that contain deciduous species.

This implementation of 3-PG includes several major variants / modifications of the model in particular the ability to switch between 3-PGpjs (the more classic model version for monospecific stands) vs. 3-PGmix (a version for mixed stands), as well as options for bias corrections and $\delta^1 3C$ calculations (see parameters).

Value

either a 4-dimentional array or a data.frame, depending on the parameter `df_out`. More details on the output is `i_output`

Note

The `run_3PG` also checks the quality of input data. When names, or structures are not consistent with requirements it will return an error. Turn this off to optimize for speed.

References

Forrester, D. I., 2020. 3-PG User Manual. Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf, Switzerland. 70 p. Available at the following web site: http://sites.google.com/site/davidforresterssite/home/projects/3PGmix/3pgmixdownload

Forrester, D. I., & Tang, X. (2016). Analysing the spatial and temporal dynamics of species interactions in mixed-species forests and the effects of stand density using the 3-PG model. Ecological Modelling, 319, 233–254. doi:10.1016/j.ecolmodel.2015.07.010

Landsberg, J. J., & Waring, R. H., 1997. A generalised model of forest productivity using simplified concepts of radiation-use efficiency, carbon balance and partitioning. Forest Ecology and Management, 95(3), 209–228. doi:10.1016/S03781127(97)000261

Sands, P. J., 2010. 3PGpjs user manual. Available at the following web site: https://3pg.sites.olt.ubc.ca/files/2014/04/3PGpjs_UserManual.pdf

See Also

`prepare_input`, `prepare_parameters`, `prepare_sizeDist`, `prepare_thinning`, `prepare_climate`

Examples

```
out <- run_3PG(
  site = d_site,
  species = d_species,
```

```
  climate = d_climate,
  thinning = d_thinning,
  parameters = d_parameters,
  size_dist = d_sizeDist,
  settings = list(light_model = 2, transp_model = 2, phys_model = 2,
                  correct_bias = 1, calculate_d13c = 0),
  check_input = TRUE, df_out = TRUE) # note that default is TRUE

str(out) # List output format
```

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