Package 'forestat'

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Type Package

Title Forest Carbon Sequestration and Potential Productivity Calculation

Version 1.1.0

Description Include assessing site classes based on the stand height growth and establishing a nonlinear mixed-effect biomass model under different site classes based on the whole stand model to achieve more accurate estimation of carbon sequestration. In particular, a carbon sequestration potential productivity calculation method based on the potential mean annual increment is proposed. This package is applicable to both natural forests and plantations. It can quantitatively assess stand's potential productivity, realized productivity, and possible improvement under certain site, and can be used in many aspects such as site quality assessment, tree species suitability evaluation, and forest degradation evaluation. Reference: Lei X, Fu L, Li H, et al (2018) <doi:10.11707/j.1001-7488.20181213>. Fu L, Sharma R P, Zhu G, et al (2017) <doi:10.3390/f8040119>.

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Suggests knitr, rmarkdown

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R topics documented:

`calc_degraded_forest_grade`
Calculating degraded forest grade

Description

Calculation of degraded forest grade.

Usage

```
calc_degraded_forest_grade(plot_data)
```

Arguments

`plot_data`	Preprocessed plot_data

Details

Calculation of degraded forest grade, icluding p1, p2,p3, p4, p5, p1m, p2m, p3m, p4m, Z1, Z2, Z3, Z4, Z5, Z, Z_weights, Z_grade, Z_weights_grade etc.

Value

res_data with degraded forest grade

Examples

```
# Load forest survey data
data(tree_1)
data(tree_2)
data(tree_3)
data(plot_1)
data(plot_2)
data(plot_3)

# Preprocess the degraded forest data
plot_data <- degraded_forest_preprocess(tree_1,tree_2,tree_3,plot_1,plot_2,plot_3)

# Calculation of degraded forest grade
res_data <- calc_degraded_forest_grade(plot_data)
```

---

class.plot *Calculate the site classes based on stand height growth*

Description

class.plot adds new variables: the original height classes and the adjusted height classes. And the existing variables are retained.

Usage

```
class.plot(
  data,
  model = "Richards",
  interval = 5,
  number = 5,
  maxiter = 1000,
  H_start = c(a = 20, b = 0.05, c = 1),
  BA_start = c(a = 80, b = 1e-04, c = 8, d = 0.1),
  Bio_start = c(a = 450, b = 1e-04, c = 12, d = 0.1)
)
```

Arguments

data	A data.frame data in which at least four columns are required as input: ID, code, AGE, H.
model	Type of model used for building the H-model (stand height model), options are 'Logistic', 'Richards', 'Korf', 'Gompertz', 'Weibull', or 'Schumacher'.
interval	The initial stand age interval for height classes.
number	The maximum number of initial height classes.
maxiter	The maximum number of iterations to fit the H-model.
H_start	The initial parameters for fitting the H-model, the default value is c(a=20,b=0.05,c=1.0).
BA_start	The initial parameters for fitting the BA-model, the default value is c(a = 80, b = 0.0001, c = 8, d = 0.1).
Bio_start	The initial parameters for fitting the Bio-model, the default value is c(a=450, b=0.0001, c=12, d=0.1).

Details

Input takes a data.frame with three variables ID, AGE, H and returns height classes of every sample (rows in the data.frame).

Value

A data of forestData class with output values, models and model parameters.

Examples

```
# Load sample data
data("forestData")

# Build a model based on the forestData and return a forestData class object
forestData <- class.plot(forestData,model="Richards",
                         interval=5,number=5,maxiter=1000,
                         H_start=c(a=20,b=0.05,c=1.0))
```

---

degraded_forest_preprocess

Preprocess the degraded forest data

Description

Preprocess the degraded forest data and return the plot_data.

Usage

```
degraded_forest_preprocess(tree_1, tree_2, tree_3, plot_1, plot_2, plot_3)
```

Arguments

tree_1	Tree data for the 1st period
tree_2	Tree data for the 2nd period
tree_3	Tree data for the 3rd period
plot_1	Sample plot data for the 1st period
plot_2	Sample plot data for the 2nd period
plot_3	Sample plot data for the 3rd period

Details

tree_1, tree_2, tree_3 are required to include the fields "plot_id", "inspection_type", and "tree_species_code". plot_1, plot_2, and plot_3 are required to include the fields "plot_id", "standing_stock", "forest_cutting_stock", "crown_density", "disaster_level", "origin", "dominant_tree_species", "age_group", "naturalness", and "land_type".

Value

Preprocessed plot_data

Examples

```
# Load forest survey data
data(tree_1)
data(tree_2)
data(tree_3)
data(plot_1)
data(plot_2)
data(plot_3)

# Preprocess the degraded forest data
plot_data <- degraded_forest_preprocess(tree_1,tree_2,tree_3,plot_1,plot_2,plot_3)
```

---

forestData *Mixed birch-broadleaf forest data*

Description

Mixed birch-broadleaf forest data

Usage

```
forestData
```

Format

'forestData' A data frame with 320 rows and 16 columns:

ID Plot ID

AGE The average age of the stand

H Stand height

BA Stand basal area

Bio Stand biomass

S Stand density index

code Forest type code of plot ...

`plot.forestData` *ForestData Plot*

Description

Plot graphs about the forestData.

Usage

```
## S3 method for class 'forestData'
plot(
  x,
  model.type = "H",
  plot.type = "Curve",
  xlab = NA,
  ylab = NA,
  legend.lab = "Site class",
  title = "Mixed birch-broadleaf forest",
  ...
)
```

Arguments

`x`	A data of forestData class.
`model.type`	Type of model used for fitting, options are 'H' (stand height growth model), 'BA' (stand basal area model), or 'Bio' (stand biomass model).
`plot.type`	Type of plot, options are 'Curve' (curve plot), 'Scatter_Curve' (scatter plot with curve), 'Residual' (residual plot), or 'Scatter' (scatter plot).
`xlab`	The title for the x axis.
`ylab`	The title for the y axis.
`legend.lab`	The title for the legends.
`title`	The text for the Plot title.
`...`	Additional arguments affecting the figure plotted.

Value

A trellis plot object

Examples

```
# Load sample data
data("forestData")

# Build a model based on the forestData and return a forestData class object
forestData <- class.plot(forestData,model="Richards",
                         interval=5,number=5,maxiter=1000,
                         H_start=c(a=20,b=0.05,c=1.0))

# Plot the curve of the height classes
plot(forestData, model.type="H",
     plot.type="Curve",
     xlab="Stand age (year)",ylab="Height (m)",legend.lab="Site class",
     title="The H-model curve of the mixed birch-broadleaf forest")
```

---

plot_1 *1st period sample plot survey data*

Description

The 1st period sample plot survey data (e.g. 2005)

Usage

```
plot_1
```

Format

'plot_1' A data frame with 62 rows and 23 columns:

plot_id Plot ID

standing_stock Standing stock

forest_cutting_stock Forest cutting stock

crown_density Crown density

disaster_level Disaster level

origin origin

dominant_tree_species Dominant tree species

age_group Age group

naturalness Naturalness

land_type Land type ...

plot_2 *2nd period sample plot survey data*

Description

The 2nd period sample plot survey data (e.g. 2010)

Usage

```
plot_2
```

Format

'plot_2' A data frame with 100 rows and 5 columns:

plot_id Plot ID

standing_stock Standing stock

forest_cutting_stock Forest cutting stock

crown_density Crown density

disaster_level Disaster level

origin origin

dominant_tree_species Dominant tree species

age_group Age group

naturalness Naturalness

land_type Land type ...

plot_3 *3rd period sample plot survey data*

Description

The 3rd period sample plot survey data (e.g. 2015)

Usage

```
plot_3
```

Format

'plot_3' A data frame with 100 rows and 5 columns:

plot_id Plot ID

standing_stock Standing stock

forest_cutting_stock Forest cutting stock

crown_density Crown density

disaster_level Disaster level

origin origin

dominant_tree_species Dominant tree species

age_group Age group

naturalness Naturalness

land_type Land type ...

---

potential.productivity

Calculate the potential productivity.

Description

potential.productivity calculate the potential productivity of stand based on model parameters(obtained from the parameterOutput function).

Usage

```
potential.productivity(
  forestData,
  code = 1,
  age.min = 5,
  age.max = 150,
  left = 0.05,
  right = 100,
  e = 1e-05,
  maxiter = 50
)
```

Arguments

forestData	A forestData class data
code	Codes for forest types.
age.min	The minimum age of the stand.
age.max	The maximum age of the stand.
left	Solving for the left boundary of the potential productivity.

right	Solving for the right boundary of the potential productivity.
e	Accuracy parameters for solving the stand density index according to Newton's iterative method.
maxiter	Maximum number of iterations parameter for solving the stand density index according to Newton's iteration method.

Details

potential.productivity takes data_BA,data_V parameters as required inputs.

Value

A forestData class in which a data.frame with potential productivity parameters is added.

Examples

```
# Load sample data
data("forestData")

# Build a model based on the forestData and return a forestData class object
forestData <- class.plot(forestData,model="Richards",
                         interval=5,number=5,maxiter=1000,
                         H_start=c(a=20,b=0.05,c=1.0))

# Calculate the potential productivity of the forestData object
forestData <- potential.productivity(forestData,code=1,
                                     age.min=5,age.max=150,
                                     left=0.05,right=100,
                                     e=1e-05,maxiter=50)
```

---

realized.productivity *Calculate the realized productivity.*

Description

realized.productivity calculate the realized productivity of each stand based on model parameters (obtained from the parameterOutput function).

Usage

```
realized.productivity(forestData, left = 0.05, right = 100)
```

Arguments

forestData	A forestData class data
left	Solving for the left boundary of the realized productivity.
right	Solving for the right boundary of the realized productivity.

Details

realized.productivity takes data,data_BA,data_V parameters as required inputs.

Value

A forestData class in which a data.frame with realized productivity parameters is added.

Examples

```
# Load sample data
data("forestData")

# Build a model based on the forestData and return a forestData class object
forestData <- class.plot(forestData,model="Richards",
                         interval=5,number=5,maxiter=1000,
                         H_start=c(a=20,b=0.05,c=1.0))

# Calculate the realized productivity of the forestData object
forestData <- realized.productivity(forestData,left=0.05,right=100)
```

---

summary.forestData *Summary of forestData*

Description

Generates summary statistics for forestData objects.

Usage

```
## S3 method for class 'forestData'
summary(object, ...)
```

Arguments

object	A forestData object (after class.plot).
...	Additional arguments affecting the summary produced.

Details

The summary includes the summary of raw data, the model, the model parameters, potential productivity and real productivity in forestData(if available)

Value

A summary object of class "summary.forestData"

Examples

```
# Load sample data
data("forestData")

# Build a model based on the forestData and return a forestData class object
forestData <- class.plot(forestData,model="Richards",
                         interval=5,number=5,maxiter=1000,
                         H_start=c(a=20,b=0.05,c=1.0))

# Get the summary data of the forestData object
summary(forestData)
```

---

tree_1 *1st period trees survey data*

Description

The 1st period trees survey data (e.g. 2005)

Usage

```
tree_1
```

Format

'tree_1' A data frame with 1634 rows and 5 columns:

plot_id Plot ID

inspection_type Inspection type

tree_species_code Tree species code ...

---

tree_2 *2nd period trees survey data*

Description

The 2nd period trees survey data (e.g. 2010)

Usage

```
tree_2
```

Format

'tree_2' A data frame with 4778 rows and 5 columns:

plot_id Plot ID

inspection_type Inspection type

tree_species_code Tree species code ...

`tree_3` *3rd period trees survey data*

Description

The 3rd period trees survey data (e.g. 2015)

Usage

```
tree_3
```

Format

'tree_3' A data frame with 4528 rows and 5 columns:

plot_id Plot ID

inspection_type Inspection type

tree_species_code Tree species code ...

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