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>.
License GPL (>= 3)
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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
class.plot

Details

Calculation of degraded forest grade, including 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)
)

degraded_forest_preprocess

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

```r
# 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)
forestData

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

```r
# 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)
```

---

**Description**

Mixed birch-broadleaf forest data

**Usage**

`forestData`
Format

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

<table>
<thead>
<tr>
<th>ID</th>
<th>Plot ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td>The average age of the stand</td>
</tr>
<tr>
<td>H</td>
<td>Stand height</td>
</tr>
<tr>
<td>BA</td>
<td>Stand basal area</td>
</tr>
<tr>
<td>Bio</td>
<td>Stand biomass</td>
</tr>
<tr>
<td>S</td>
<td>Stand density index</td>
</tr>
</tbody>
</table>
| 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:

<table>
<thead>
<tr>
<th>Column</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>plot_id</td>
<td>Plot ID</td>
</tr>
<tr>
<td>standing_stock</td>
<td>Standing stock</td>
</tr>
<tr>
<td>forest_cutting_stock</td>
<td>Forest cutting stock</td>
</tr>
<tr>
<td>crown_density</td>
<td>Crown density</td>
</tr>
<tr>
<td>disaster_level</td>
<td>Disaster level</td>
</tr>
<tr>
<td>origin</td>
<td>origin</td>
</tr>
<tr>
<td>dominant_tree_species</td>
<td>Dominant tree species</td>
</tr>
<tr>
<td>age_group</td>
<td>Age group</td>
</tr>
<tr>
<td>naturalness</td>
<td>Naturalness</td>
</tr>
<tr>
<td>land_type</td>
<td>Land type ...</td>
</tr>
</tbody>
</table>
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
potential.productivity

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>forestData</td>
<td>A forestData class data</td>
</tr>
<tr>
<td>code</td>
<td>Codes for forest types.</td>
</tr>
<tr>
<td>age.min</td>
<td>The minimum age of the stand.</td>
</tr>
<tr>
<td>age.max</td>
<td>The maximum age of the stand.</td>
</tr>
<tr>
<td>left</td>
<td>Solving for the left boundary of the potential productivity.</td>
</tr>
</tbody>
</table>
realized.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

```r
# 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

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>forestData</td>
<td>A forestData class data</td>
</tr>
<tr>
<td>left</td>
<td>Solving for the left boundary of the realized productivity.</td>
</tr>
<tr>
<td>right</td>
<td>Solving for the right boundary of the realized productivity.</td>
</tr>
</tbody>
</table>
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

```r
# 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

```r
## 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

```r
# 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**

```r
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**

```r
tree_2
```
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 ...

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 ...
Index

* datasets
  forestData, 5
  plot_1, 7
  plot_2, 8
  plot_3, 8
  tree_1, 12
  tree_2, 12
  tree_3, 13
  calc_degraded_forest_grade, 2
  class.plot, 3
  degraded_forest_preprocess, 4
  forestData, 5
  plot.forestData, 6
  plot_1, 7
  plot_2, 8
  plot_3, 8
  potential.productivity, 9
  realized.productivity, 10
  summary.forestData, 11
  tree_1, 12
  tree_2, 12
  tree_3, 13