Package ‘HydroMe’

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Type Package

Title Estimating Water Retention and Infiltration Model Parameters
using Experimental Data

Version 2.0-1

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Imports stats

Suggests minpack.lm, nlme

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Description This version 2 of the HydroMe v.1 package estimates the parameters
in infiltration and water retention models by curve-
fitting methods <doi:10.1016/j.cageo.2008.08.011>. The
models considered are those commonly used in soil science. It has new models
for water retention and characteristic curves.

License GPL (>= 2)

URL https://CRAN.r-project.org/package=HydroMe

NeedsCompilation no

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R topics documented:

`HydroMe2-package` *R codes for estimating water retention and infiltration model parameters using experimental data*

Description

This package is version 2 of HydroMe v.1 package. It estimates the parameters in infiltration and water retention models by curve-fitting method. The models considered are those that are commonly used in soil science. It has new models for water retention characteristic curve and debugging of errors in HydroMe v.1

Details

Package:	HydroMe2
Type:	Package
Version:	1.0
Date:	2013-04-29
License:	GPL

The package contains hydraulic functions whose parameters are estimated from experimental data. The functions are supposed to be specified, the input data, and associated parameters declared in a standard regression modelling fashion. Where starting variables are needed, the package has a function known as Dstart for determining the starting variables

Author(s)

Christian Thine Omuto

Maintainer: Christian Thine Omuto <thineomuto@yahoo.com>

References

Omuto CT and Gumbe LO. 2009. Estimating water infiltration and retention characteristics using a computer program in R. Computers and Geosciences 35: 579-585

Examples

```
data(infilt)
require("minpack.lm")
gamp.ns <- nlsLM(Rate ~ SSgampt(Time,ks,A), infilt)
summary(gamp.ns)
data(isric)
isric1 <- isric[1:32,]
require("nlme")
omuto <- nlsList(y~SSomuto(x,ths1,alp1,ths2,alp2)|Sample, isric1)
omuto.nlme <- nlme(omuto)## for fitting mixed-effects models
summary(omuto.nlme)
```

Brook *Brook-Corey water retention model*

Description

This is a four-parameter function to determine water retention hydraulic parameters contained in the Brooks-Corey water retention model

Usage

```
Brook(x, thr, ths, alp, nscal)
```

Arguments

`x`	Suction potential/head as contained in the x-column of the xy water retention table or data
`thr`	This is the residual moisture content. It's the moisture content when suction potential is very high (almost at the drying point)
`ths`	This is the saturated moisture content. It's the moisture content when suction potential is very low (almost at the saturation point)
`alp`	It's the inverse of air-entry potential or bubbling pressure
`nscal`	This is a parameter or index for the pore-size distribution

Details

A Brooks-Corey model is a type of nonlinear curve fitting model for fitting water retention characteristics using experimental data. It requires initial parameter estimates for the model to work. This can be obtained using Dstart function (e.g. thr=Dstart(data)[1]). If warnings are given during the estimation process, try to increase the iteration limit using control function. Sometimes the warnings can be suppressed using (warn=-1)/ignored since they do not terminate the process

Value

A list of objects returned by standard R regression functions such as nls and lm

Author(s)

Christian Thine Omuto

References

Brooks RH and Corey AT.1964. Hydraulic properties of porous medium. Hydrology Paper Number 3. Colorado State University, USA

See Also

SSvgm, SSgard, Campbel

Examples

```
## Attach sample data (isric data) from the package
data(isric)
pf <- subset(isric, Sample=="Benin2")
require("minpack.lm")
brook.ns <- nlsLM(y ~ Brook(x,thr,ths,alp,nscal), data=pf,
                  control = nls.lm.control(maxiter=200),
                  start = c(thr= Dstart(pf)[1], ths = Dstart(pf)[2],
                            alp= Dstart(pf)[3], nscal=Dstart(pf)[4]-1))
summary(brook.ns)## To produce a summary of modelling results
```

Campbel *Campbell water retention model*

Description

This is a three-parameter function to determine water retention hydraulic parameters contained in the Campbell water retention model

Usage

```
Campbel(x, ths, alp, nscal)
```

Arguments

x	Suction potential/head as contained in the x-column of the xy water retention table or data
ths	This is the saturated moisture content. It's the moisture content when suction potential is very low (almost at the saturation point)
alp	It's the inverse of air-entry potential or bubbling pressure
nscal	This is a parameter or index for the pore-size distribution. nscal=1/b, where b is empirical parameter in the original Campbel model

Details

A Campbell model is a type of nonlinear curve fitting model for fitting water retention characteristics using experimental data. It requires initial parameter estimates for the model to work. This can be obtained using Dstart function (e.g. thr=Dstart(data)[1]). If warnings are given during the estimation process, try to increase the iteration limit using control function. Sometimes the warnings can be suppressed using (warn=-1)/ignored since they do not terminate the process

Value

A list of objects returned by standard R regression functions such as nls and lm

Note

Warnings: Choice of starting values for Campbel function parameter estimation needs a careful thought. Sometimes it may be necessary to use alp=1/Dstart(data)[3] or Dstart(data)[3] and nscal=Dstart(data)[4]-1 or nscal=Dstart(data)[4]. One has to try the starting variables that will work for the given data

Author(s)

Christian Thine Omuto

References

Campbell GS. 1974. A simple method for determining unsaturated conductivity from moisture retention data. Soil Science 117: 311-314

See Also

Brook, SSvgm, SSfredlund

Examples

```
data(isric)
pf <- subset(isric, Sample=="Nicaragua38")
require("minpack.lm")
campbel.ns <- nlsLM(y ~ Campbel(x,ths,alp,nscal), data=pf,
                  control = nls.lm.control(maxiter=200),
                  start = c(ths = Dstart(pf)[2],
                             alp=Dstart(pf)[3], nscal=-1*(Dstart(pf)[4]-1)))
plot(fitted(campbel.ns),pf$y)
coef(campbel.ns)
```

Dstart *Determine starting values for nonlinear parameter estimation in the water retention models*

Description

This function determines the starting values for estimation of parameters in the water retention models. The input data must contain at least the x (suction potential) and y(moisture contents) variables. It gives the starting values as close to the expected estimates as possible.

Usage

```
Dstart(data)
```

Arguments

data	This is the water retention data with at least x (suction potential) and y(moisture contents) variables. The number of rows of the data should be at least 4 entries/levels of suction potential

Details

The data contains x columns and y columns which are used by the function. The initial x value should not be zero but something close like 0.001

Value

A vector of five values: pars[1]: thr- The residual moisture content, pars[2]: ths- The saturated moisture content, Pars[3]: alp- Inverse of air entry potential, pars[4]: nscal-index of pore-size distribution, and pars[5]: mscal-scaling parameter related to nscal

Author(s)

Christian Thine Omuto

See Also

SSvgm, Sskosugi, SSgard

Examples

```
data(isric)
pf=subset(isric, Sample=="Benin3")
Dstart(pf)[1]## thr initial value
```

`Expo` *Exponential water retention model*

Description

This is a three- parameter function to determine water retention hydraulic parameters contained in the Exponential water retention model

Usage

```
Expo(x, thr, ths, alp)
```

Arguments

`x`	Suction potential/head as contained in the x-column of the xy water retention table or data
`thr`	This is the residual moisture content. It's the moisture content when suction potential is very high (almost at the drying point)
`ths`	This is the saturated moisture content. It's the moisture content when suction potential is very low (almost at the saturation point)
`alp`	It's the inverse of air-entry potential or bubbling pressure

Details

An exponential model is a type of nonlinear curve fitting model for fitting water retention characteristics using experimental data. It requires initial parameter estimates for the model to work. This can be obtained using Dstart function (e.g. thr=Dstart(data)[1]). If warnings are given during the estimation process, try to increase the iteration limit using control function. Sometimes the warnings can be suppressed using (warn=-1)/ignored since they do not terminate the process

Value

A list of objects returned by standard R regression functions such as nls and lm

Author(s)

Christian Thine Omuto

References

Omuto CT. 2009. Biexponential model for water retention characteristics. Geoderma 149:235-242

See Also

SSomuto, SSfredlund

Examples

```
##Attach sample data (isric data) from the package
data(isric)
pf <- subset(isric, Sample=="Benin2")
require("minpack.lm")
expo.ns <- nlsLM(y ~ Expo(x,thr,ths,alp), data=pf,
                 control = nls.lm.control(maxiter=200),
                 start = c(thr=Dstart(pf)[1],ths=Dstart(pf)[2], alp=Dstart(pf)[3]))
cor(fitted(expo.ns),pf$y)^2
```

---

infilt *Water infiltration characteristics data*

Description

This is part of a dataset from a PhD study which measured water infiltration characteristics from the Upper Athi River basin in Eastern Kenya. It contains rate of infiltration (y) at different levels of cummulative Time intervals (x)

Usage

```
data(infilt)
```

Format

A data frame with 1105 observations on the following 6 variables.

`Sample` which is a numeric vector

`PlotNo` which is a factor with levels such as: `10lP3` `11lP3` `12lP3` `13lP3` `14lP3` `15lP3` `16lP3` `17lP3` `18lP3` `19lP3` `1lP3` `20lP3` `21lP3` `22lP3` `23lP3` `24lP3` `25lP3` `26lP3` `27lP3` `28lP3` `29lP3` `2lP3` `30lP3` `3lP3` `4lP3` `5lP3` `6lP3` `7lP3` `8lP3` `9lP3`

`Erosion` which is a factor with levels such as: `E0` `E1` `E2`

`Time` which is a numeric vector of cumulative infiltration time

`Rate` which is a numeric vector of instantaneous infiltration rate

`Cumrate` which is a numeric vector of cumulative infiltration rate

Details

The data is grouped according to plots (given the name PlotNo) from where the data were collected

Source

Omuto CT. 2006. Large-area soil physical degradation assessment using gis, remote sensing, and infrared spectroscopy in arid and semi-arid Kenya. PhD Dissertation, University of Nairobi, Kenya

References

Omuto CT. 2006. Large-area soil physical degradation assessment using gis, remote sensing, and infrared spectroscopy in arid and semi-arid Kenya.PhD Dissertation, University of Nairobi, Kenya

Examples

```
data(infilt)
str(infilt)
```

---

isric — *Water Retention World Dataset from ISRIC*

Description

This is part of world dataset of measured water retention characteristics. It contains soil moisture contents (y) at eight (8) levels of suction pressure heads (x).

Usage

```
data(isric)
```

Format

A data frame with 320 observations on the following 6 variables.

`Sample` which is a factor with levels such as: `Benin1` `Benin2` `Benin3` `Italy4` `Italy5` `Italy6` `Italy7` `Nicaragua21` `Nicaragua22` `Nicaragua23` `Nicaragua24` `Nicaragua25` `Nicaragua26` `Nicaragua27` `Nicaragua28` `Nicaragua29` `Nicaragua30` `Nicaragua31` `Nicaragua32` `Nicaragua33` `Nicaragua34` `Nicaragua35` `Nicaragua36` `Nicaragua37` `Nicaragua38` `Nicaragua39` `Nicaragua40` `Poland10` `Poland11` `Poland8` `Poland9` `Rwanda16` `Rwanda17` `Rwanda18` `Rwanda19` `Rwanda20` `Togo12` `Togo13` `Togo14` `Togo15`

`Country` which is a factor with levels such as: `Benin` `Italy` `Nicaragua` `Poland` `Rwanda` `Togo`

`BD` which is a numeric vector for bulk density

`x` which is a numeric vector for suction potential

`lnx` which is a numeric vector for log(e)

`y` which is a numeric vector of moisture contents

Details

The data is grouped according to samples from each country from where the data were collected. In addition, it also contains surface bulk density (BD) for each sample. The whole dataset can be obtained from www.isric.org

Source

https://www.isric.org/

Examples

```
data(isric)
str(isric)
```

MB *McKee and Bumb water retention model*

Description

This is a three- parameter function to determine water retention hydraulic parameters contained in the McKee and Bumb water retention model

Usage

```
MB(x,thr,ths,alp)
```

Arguments

`x`	Suction potential/head as contained in the x-column of the xy water retention table or data
`thr`	This is the residual moisture content.It's the moisture content when suction potential is very high (almost at the drying point)
`ths`	This is the saturated moisture content. It's the moisture content when suction potential is very low (almost at the saturation point)
`alp`	This is the inverse of air-entry potential or bubbling pressure

Details

McKee and Bumb model is a type of nonlinear curve fitting model for fitting water retention characteristics using experimental data. It requires initial parameter estimates for the model to work. This can be obtained using Dstart function (e.g. thr=Dstart(data)[1]). If warnings are given during the estimation process, try to increase the iteration limit using control function. Sometimes the warnings can be suppressed using (warn=-1)/ignored since they do not terminate the process

Value

A list of objects returned by standard R regression functions such as nls and lm

Note

Warnings: Choice of starting values for SSMB function parameter estimation needs a careful thought. Sometimes it may be necessary to use alp=1/Dstart(data)[3] or Dstart(data)[3]. One has to try the starting variables that will work for the given data.

Author(s)

Christian Thine Omuto

References

McKee CR and Bumb AC.1987. Flow-testing coalbed methane production wells in presence of water and gas. SPE Formation Evaluation,vol. 2, no. 4, pp. 599–608

See Also

SSomuto, Expo, Campbel

Examples

```
##Attach sample data (isric data) from the package
data(isric)
require("minpack.lm")
pf <- subset(isric, Sample=="Italy5")
mb.ns=nlsLM(y~MB(x,thr,ths,alp),data=pf, control=nls.lm.control(maxiter=200),
            start=c(thr=Dstart(pf)[1],ths=Dstart(pf)[2], alp=Dstart(pf)[3]))
summary(mb.ns)
coef(mb.ns)
```

Ruso — *A Russo water retention model*

Description

This is a four- parameter function to determine water retention hydraulic parameters contained in the Russo water retention model

Usage

```
Ruso(x, thr, ths, alp, nscal)
```

Arguments

`x`	Suction potential/head as contained in the x-column of the xy water retention table or data
`thr`	This is the residual moisture content. It's the moisture content when suction potential is very high (almost at the drying point)
`ths`	This is the saturated moisture content. It's the moisture content when suction potential is very low (almost at the saturation point)
`alp`	It's the inverse of air-entry potential or bubbling pressure
`nscal`	This is a parameter or index for the pore-size distribution

Details

A Russo model is a type of nonlinear curve fitting model for fitting water retention characteristics using experimental data. It requires initial parameter estimates for the model to work. This can be obtained using Dstart function (e.g. thr=Dstart(data)[1]). If warnings are given during the estimation process, try to increase the iteration limit using control function. Sometimes the warnings can be suppressed using (warn=-1)/ignored since they do not terminate the process

Value

A list of objects returned by standard R regression functions such as nls and lm

Author(s)

Christian Thine Omuto

References

Russo D. 1988. Determining soil hydraulic properties by parameter estimation: on the selection of a model for the hydraulic properties. Water Resources Research 24(3): 453-459

See Also

Campbel, Brook, Tani

Examples

```
## Attach sample data (isric data) from the package
data(isric)
pf <- subset(isric, Sample=="Italy5")
require("minpack.lm")
ruso.ns <- nlsLM(y ~ Ruso(x,thr,ths,alp,nscal), data=pf,
                 control = nls.lm.control(maxiter=200),
                 start = c(thr= Dstart(pf)[1], ths = Dstart(pf)[2],
                           alp= Dstart(pf)[3], nscal=Dstart(pf)[4]))
coef(ruso.ns)
```

SSfredlund — *A Fredlund-Xing water retention model*

Description

This is a five- parameter function to determine water retention hydraulic parameters contained in the Fredlund-Xing water retention model

Usage

```
SSfredlund(x, thr, ths, alp, nscal, mscal)
```

Arguments

`x`	Suction potential/head as contained in the x-column of the xy water retention table or data
`thr`	This is the residual moisture content. It's the moisture content when suction potential is very high (almost at the drying point)
`ths`	This is the saturated moisture content. It's the moisture content when suction potential is very low (almost at the saturation point)

`alp`	It's the inverse of air-entry potential or bubbling pressure
`nscal`	This is a parameter or index for the pore-size distribution
`mscal`	This is a scaling parameter which is also related to the index for the pore-size distribution

Details

A Fredlund-Xing model is a self-starting type of nonlinear curve fitting model for fitting water retention characteristics using experimental data. If warnings are given during the estimation process, try to increase the iteration limit using control function. Sometimes the warnings can be suppressed using (warn=-1)/ignored since they do not terminate the process

Value

A list of objects returned by standard R regression functions such as nls and lm

Author(s)

Christian Thine Omuto

References

Fredlund DG and Xing A. 1994. Equations for the soil-water characteristic curve. Canadian Geotechnical Journal 31: 521-532

See Also

SSomuto, SSvgm, SSkosugi

Examples

```
## Attach sample data (isric data) from the package
data(isric)
pf <- subset(isric, Sample=="Benin2")
require("minpack.lm")
fredlund.ns <- nlsLM(y ~ SSfredlund(x,thr,ths,alp,nscal,mscal), data=pf,
                     control = nls.lm.control(maxiter=200,options(warn=-1)))
coef(fredlund.ns)
plot(fitted(fredlund.ns)~pf$y)
```

`SSgampt` *A Green-Ampt water infiltration model*

Description

This is a two- parameter function to determine water infiltration parameters contained in the Green-Ampt infiltration model

Usage

```
SSgampt(input, ks, A)
```

Arguments

`input`	Instantaneous infiltration rate
`ks`	Saturated hydraulic conductivity
`A`	Constant incorporating matric suction potential, wetting front, and antecedent moisture content

Details

This is a self-starting model for estimating Green-Ampt infiltration model using instantaneous and cumulative infiltration data

Value

A list of objects returned by standard R regression functions such as nls and lm

Author(s)

Christian Thine Omuto

References

Green WA and Ampt GA. 1911. Studies on soil physics: 1. The flow of air and water through soils. Journal of Agricultural Science 4: 1-24

See Also

SSphilip, SShorton

Examples

```
## Load the data
data(infilt)
require("minpack.lm")
gamp.ns <- nlsLM(Cumrate ~ SSgampt(Rate,ks,A), infilt)
summary(gamp.ns)
```

`SSgard` *'Gardner' Water Retention Model for Grouped Data*

Description

This is a four-parameter function to determine water retention hydraulic parameters contained in the Gardner water retention model

Usage

```
SSgard(input, Thr, Ths, alp, scal)
```

Arguments

`input`	Suction potential/head as contained in the x-column of the xy water retention table or data
`Thr`	This is the residual moisture content. It's the moisture content when suction potential is very high (almost at the drying point)
`Ths`	This is the saturated moisture content. It's the moisture content when suction potential is very low (almost at the saturation point)
`alp`	It's the inverse of air-entry potential or bubbling pressure
`scal`	This is a parameter or index for the pore-size distribution

Details

A Gardner model is a type of self-starting nonlinear curve fitting model for fitting water retention characteristics using grouped experimental data. If warnings are given during the estimation process, try to increase the iteration limit using control function. Sometimes the warnings can be suppressed using (warn=-1)/ignored since they do not terminate the process

Value

A list of objects returned by standard R regression functions such as nls and lm

Author(s)

Christian Thine Omuto

References

Gardner WR. 1958. Some steady state solutions of the unsaturated moisture flow equation with application to evaporation from a water table. Soil Science 85, 228-232

See Also

SSvgm, SSomuto, Campbel

Examples

```
data(isric)
isric1 <- isric[1:32,]
require("nlme")
require("minpack.lm")
gardner <- nlsLM(y ~ SSgard(x,thr,ths,alp,nscal), isric1)
gardner
gard <- nlsList(y ~ SSgard(x,thr,ths,alp,scal) | Sample, isric1)
coef(gard)
```

SShorton *A Horton water infiltration model*

Description

This is a three- parameter function to determine water infiltration parameters contained in the Horrton infiltration model

Usage

```
SShorton(input, fc, f0, lrk)
```

Arguments

input	Time
fc	Steady infiltration rate
f0	Initial infiltration rate
lrk	Shape factor related to soil pore continuity

Details

This is a self-starting model for estimating parameters in the Horton infiltration model using instantaneous infiltration rates (here known as Rate) and time data (Time)

Value

A list of objects returned by standard R regression functions such as nls and lm

Author(s)

Christian Thine Omuto

References

Horton RE. 1940. An approach towards a physical interpretation of infiltration capacity. Soil Science Society of America Proceedings 5: 227-237

See Also

SSphilip, SSgampt

Examples

```
data(infilt)
infil <- infilt[319:751,]
require("nlme")
hort.lis <- nlsList(log(Rate) ~ SShorton(Time,fc,f0,lrk) | PlotNo,
                    infil) # Rate is the y variable
hort.lis
```

SSkosugi   *A Kosugi water retention model*

Description

This is a four- parameter function to determine water retention hydraulic parameters contained in the Kosugi water retention model

Usage

```
SSkosugi(x, thr, ths, alp, nscal)
```

Arguments

x	Suction potential/head as contained in the x-column of the xy water retention table or data
thr	This is the residual moisture content. It's the moisture content when suction potential is very high (almost at the drying point)
ths	This is the saturated moisture content. It's the moisture content when suction potential is very low (almost at the saturation point)
alp	It's the inverse of air-entry potential or bubbling pressure
nscal	This is a parameter or index for the pore-size distribution

Details

A Kosugi model is a type of self-starting nonlinear curve fitting model for fitting water retention characteristics using experimental data. If warnings are given during the estimation process, try to increase the iteration limit using control function. Sometimes the warnings can be suppressed using (warn=-1)/ignored since they do not terminate the process

Value

A list of objects returned by standard R regression functions such as nls and lm

Author(s)

Christian Thine Omuto

References

Kosugi, K. 1996. Lognormal distribution model for unsaturated soil hydraulic properties. Water Resources Research 32: 2697-2703

See Also

SSomuto, SSvgm, SSgard

Examples

```
data(isric)
require("minpack.lm")
kosugi.ns <- nlsLM(y ~ SSkosugi(x,thr,ths,alp,nscal),
                   data = subset(isric, Sample=="Benin2"),
                   control = nls.lm.control(maxiter=200,options(warn=-1)))
summary(kosugi.ns)
```

SSomuto *'Omuto' Water Retention Model*

Description

This is a four- parameter function to determine water retention hydraulic parameters contained in a bimodal pore-size distribution developed by Omuto. The parameters are for the first and second compartments

Usage

```
SSomuto(input, Ths1, alp1, Ths2, alp2)
```

Arguments

input	Suction potential/head as contained in the x-column of the xy water retention table or data
Ths1	This is saturated moisture content in the first compartment of a bimodal pore-size distribution water retention characteristics
alp1	This is the inverse of air-entry potential in the first compartment of a bimodal pore-size distribution water retention characteristics
Ths2	This is saturated moisture content in the second compartment of a bimodal pore-size distribution water retention characteristics
alp2	This is the inverse of air-entry potential in the second compartment of a bimodal pore-size distribution water retention characteristics

Details

Omuto model is a self-starting biexponential model for nonlinear curve fitting model to water retention data. If warnings are given during the estimation process, try to increase the iteration limit using control function. Sometimes the warnings can be suppressed using (warn=-1)/ignored since they do not terminate the process

Value

A list of objects returned by standard R regression functions such as nls and lm

Note

This function can also be used to fit water retention characteristics for a grouped dataset as well as with mixed-effects modelling

Author(s)

Christian Thine Omuto

References

Omuto CT. 2009. Biexponential model for water retention characteristics. Geoderma 149:235-242

See Also

SSvgm, SSgard, SSfredlund

Examples

```
data(isric)
isric1 <- isric[1:32,]
require("nlme")
omuto <- nlsList(y ~ SSomuto(x,ths1,alp1,ths2,alp2) | Sample,  isric1)
omuto.nlme <- nlme(omuto)## for fitting mixed-effects models
summary(omuto.nlme)
```

`SSphilip` *A Philip's water infiltration model*

Description

This is a two- parameter function to determine water infiltration parameters contained in the Philip's infiltration model

Usage

```
SSphilip(input, fc, S)
```

Arguments

`input`	Time
`fc`	Steady infiltration rate
`S`	Sorptivity

Details

This is a self-starting model for estimating Philip's infiltration model using instantaneous infiltration rates (here known as Rate) and time (Time) data

Value

A list of objects returned by standard R regression functions such as nls and lm

Author(s)

Christian Thine Omuto

References

Philip JR. 1957. The theory of infiltration.: 4 Sorptivity and algebraic infiltration equations. Soil Science 84: 257-264

See Also

SShorton, SSgampt

Examples

```
data(infilt)
require("nlme")
philip.nis <- nlsList(log(Rate) ~ SSphilip(Time,fc,S) | PlotNo, data=infilt)
coef(philip.nis)
```

SSvgm — *A five-parameter van Genuchten water retention model*

Description

This is a five- parameter function to determine water retention hydraulic parameters contained in the van Genuchten water retention model

Usage

```
SSvgm(input, thr, ths, alp, nscal, mscal)
```

Arguments

`input`	Suction potential/head as contained in the x-column of the xy water retention table or data
`thr`	This is the residual moisture content. It's the moisture content when suction potential is very high (almost at the drying point)
`ths`	This is the saturated moisture content. It's the moisture content when suction potential is very low (almost at the saturation point)
`alp`	It's the inverse of air-entry potential or bubbling pressure
`nscal`	This is a parameter or index for the pore-size distribution
`mscal`	This is a scaling parameter which is also related to index for pore-size distribution

Details

Van Genuchten model is a type of self-starting nonlinear curve fitting model for fitting water retention characteristics using experimental data. In this model, the restriction of m=1-1/n has been relaxed so that m is estimated as an independent parameter of the water retention characteristics. If warnings are given during the estimation process, try to increase the iteration limit using control function. Sometimes the warnings can be suppressed using (warn=-1)/ignored since they do not terminate the process

Value

A list of objects returned by standard R regression functions such as nls and lm

Author(s)

Christian Thine Omuto

References

van Genuchten MT. 1980. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. Soil Science Society of America Journal 44: 892-898

See Also

SSomuto, Brook, Campbel

Examples

```
data(isric)
require("minpack.lm")
pf1=subset(isric,Sample=="Nicaragua21")
vn.ns <- nlsLM(y ~ SSvgm(x,thr,ths,alp,nscal,mscal),
               data = pf1,
               control = nls.lm.control(maxiter=200,options(warn=-1)))
coef(vn.ns)
plot(fitted(vn.ns)~pf1$y)
abline(a=0,b=1,lty=20, col="blue")
```

SSvgm4 *A four-parameter van Genuchten water retention model*

Description

This is a four-parameter function to determine water retention hydraulic parameters contained in the van Genuchten water retention model

Usage

```
SSvgm4(input, Thr, Ths, alp, nscal)
```

Arguments

`input`	Suction potential/head as contained in the x-column of the xy water retention table or data
`Thr`	This is the residual moisture content. It's the moisture content when suction potential is very high (almost at the drying point)
`Ths`	This is the saturated moisture content. It's the moisture content when suction potential is very low (almost at the saturation point)
`alp`	It's natural logarithm of the inverse of air-entry potential or bubbling pressure
`nscal`	This is a parameter or index for the pore-size distribution

Details

Van Genuchten model is a type of self-starting nonlinear curve fitting model for fitting water retention characteristics using experimental data. In this model, the restriction of m=1-1/n has been imposed on the water retention characteristics. Air-entry potential = exp(alp). If warnings are given during the estimation process, try to increase the iteration limit using control function. Sometimes the warnings can be suppressed using (warn=-1)/ignored since they do not terminate the process

Value

A list of objects returned by standard R regression functions such as nls and lm

Author(s)

Christian Thine Omuto

References

van Genuchten MT. 1980. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. Soil Science Society of America Journal 44: 892-898

See Also

SSomuto, Brook, Campbel

Examples

```
data(isric)
require("nlme")
require("minpack.lm")
pfdata=subset(isric,Country=="Benin")
vn4.ns <- nlsList(y ~ SSvgm4(x,thr,ths,alp,nscal)|Sample,
               data = pfdata,
               control = nls.lm.control(maxiter=200,options(warn=-1)))
coef(vn4.ns)
plot(fitted(vn4.ns)~pfdata$y)
cor(fitted(vn4.ns),pfdata$y)^2
```

`Tani` *A Tani water retention model*

Description

This is a three- parameter function to determine water retention hydraulic parameters contained in the Tani water retention model

Usage

```
Tani(x, thr, ths, alp)
```

Arguments

`x`	Suction potential/head as contained in the x-column of the xy water retention table or data
`thr`	This is the residual moisture content. It's the moisture content when suction potential is very high (almost at the drying point)
`ths`	This is the saturated moisture content. It's the moisture content when suction potential is very low (almost at the saturation point)
`alp`	It's the inverse of air-entry potential or bubbling pressure

Details

Tani model is a type of nonlinear curve fitting model for fitting water retention characteristics using experimental data. It requires initial parameter estimates for the model to work. This can be done using Dstart function (e.g. thr=Dstart(data)[1]). If warnings are given during the estimation process, try to increase the iteration limit using control function. Sometimes the warnings can be suppressed using (warn=-1)/ignored since they do not terminate the process

Value

A list of objects returned by standard R regression functions such as nls and lm

Author(s)

Christian Thine Omuto

References

Tani M. 1982. The properties of water-table rise produced by a one-dimensional, vertical, unsaturated flow. Journal of Japan Forestry Society 64: 409-418

See Also

Campbel, Brook, Ruso

Examples

```
data(isric)
pf <- subset(isric, Sample=="Italy4")
require("minpack.lm")
tani.ns <- nlsLM(y ~ Tani(x,thr,ths,alp), data = pf,
                 control = nls.lm.control(maxiter=200),
                 start = c(thr=Dstart(pf)[1],ths=Dstart(pf)[2], alp=Dstart(pf)[3]))
coef(tani.ns)
```

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