Package ‘spreval’

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Type Package

Title Sprinkler Irrigation Uniformity and Efficiency

Version 0.1.0

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Description Functions to evaluate sprinkler irrigation uniformity and efficiency using standard and other measures.

License GPL

Encoding UTF-8

LazyData true

URL https://glrabow.github.io/spreval/

Imports timeDate,akima, fields

Suggests knitr,
rmarkdown,

VignetteBuilder knitr

RoxygenNote 7.1.1

R topics documented:

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adper — *Compute percentiles of area receiving less than and greater than target depth*

Description

This returns measures of the percentage (fraction) of areas receiving less or more application than the target depth, assuming catch cans represent approximately equal areas. It also a measure of adequacy and efficiency determined from areas of a density curve receiving amounts equal to or more of the target (adequacy) and less than or equal to target (efficiency).

Usage

```
adper(x,target,plot=TRUE)
```

Arguments

`x`	array of catch can depths.
`target`	target depth meant to be applied.
`plot`	logical; plot density and ecdf plots of depths and target line.

Details

results are given as determined by both a density function and empirical cumulative distribution function (ecdf). if target is equal to soil moisture depletion, then 1- efficiency is the percentile of area that loses water to deep perolation (not held in root zone). Adequacy and efficiency percentiles should add to approximatley 1.0. Note that definitions of adequacy and efficiency here based only on percentiles is not a standard definition as deviation from target depth is not considered. See `eff` `for a more traditional approach.`

Value

named list, including;

`adequacy.density`	percentile receiving >= target amount determined from density curve
`eff.density`	percentile receiving <=target amount as determined from density curve
`adequacy.ecdf`	same as adequacy.density but as determined from ecdf function
`eff.ecdf`	same as eff.density but as determined from ecdf function

Author(s)

Garry Grabow <glgrabow@ncsu.edu>

See Also

`eff`,`density`,`ecdf`

Examples

```
#data from same exercise as PELQ example
x<-c(.23,.31,.24,.24,.28,.31,.27,.22,.26,.31,
.31,.25,.20,.22,.32)# catch can depths in inches caught during 1.0 hr. test
x<-x*23.5 # extend to 23.5 hour irrigation
target<-4.4 # replace soil water deficit of 4.4 in.
adper(x,target)
#change target to average catch
target2<-mean(x)
adper(x,target2)
```

AELQ — *Application efficiency of the low quarter, (AELQ) for a sprinkler irrigation system*

Description

AELQ is a measure of both operation (duration of irrigation) and inherent sprinkler system uniformity. AELQ is based upon soil moisture depletion (SMD) at time of irrigation, the system application rate, and irrigation duration. If the low quarter caught depth is less than or equal to the SMD, AELQ is calculated as the low quarter average caught depth (from catch cans) divided by the average applied depth (sys. app. rate x duration). If the infiltrated (caught) low quarter depth is greater than SMD, AELQ is calculated as SMD/avg. applied depth in %. Whenever the irrigation (caught or infiltrated) in the low quarter exactly matches the SMD in the low quarter AELQ=PELQ. If the duration of irrigation is such that the infiltrated depth exceeds the SMD, then AELQ will be less than PELQ.

Usage

```
AELQ(x, rate,ss,sl,dur,smd,SI=TRUE)
```

Arguments

`x`	array of catch can caught rates - not depths (mm/hr or in/hr).
`rate`	sprinkler discharge rate (lpm or gpm).
`ss`	sprinkler spacing (m or ft).
`sl`	lateral spacing (m or ft).
`dur`	duration of irrigation event, hr
`smd`	soil moisture depletion at begin irrigation, mm or in.
`SI`	logical; units SI (mm, m, lpm) or US Customary (in., ft, gpm). SI (TRUE) is default. x will be used to determine mode of AELQ computation by determining if the low quarter catch rate (and depth) is less than or greater than the SMD.

Value

AELQ (application efficiency of low quarter, %)

Author(s)

Garry Grabow <glgrabow@ncsu.edu>

References

Mirriam and Keller, 1978. Farm System Irrigation Evaluation: A Guide for Management. PP 43,44. Utah State University, Logan, Utah. https://pdf.usaid.gov/pdf_docs/PNAAG745.pdf

See Also

PELQ

Examples

```
#see pp 41-44 of reference document
x<-c(.23,.31,.24,.24,.28,.31,.27,.22,.26,.31,
.31,.25,.20,.22,.32)# catch can depths caught during test converted to in/hr
SI<-FALSE # use U.S. customary units
smd<-4.4 #soil moisture depletion of 4.4 inches
rate<-4.6 # 4.6 gpm sprinkler discharge
sl<-50; ss<-30 # 30 x 50 ft sprinkler x lateral spacing
dur<-23.5 #23.5 hr duration (24 hour set)
AELQ(x,rate,ss,sl,dur,smd,SI)
# now for a lower applied depth for alternate mode of AELQ
#computation
dur<-11.5 #change irrigation duration to a 12 hour set (11.5 hrs)
AELQ(x,rate,ss,sl,dur,smd,SI)
```

---

catchcan *catchcan data*

Description

Three catch can data sets, one each for lateral, hose pull, and solid set sprinkler systems.

Usage

```
data("catchcan")
```

Format

A named list of 3 catch can data sets; lateral, traveler, and solid.set

`catchcan$lateral` 6x7 matrix of catch can data, units are in./hr. Grid spacing of 10 ft x 10 ft

`ln` a numeric vector of catch can data - nth can to left of lateral

`rn` a numeric vector of catch can data - nth can to right of lateral

`catachcan$traveler` 16X2 matrix of catch can data. Effective (lane) spacing is 224 ft in example.

`station` distance (ft) of catch can relative to hose (0), neg. is left of hose in plan view

`depth` collected depth, in.

`catchcan$solid.set` 4x4 matrix of catch can data, units are in. Can grid spacing of 20 ft x 20 ft inside of 4 operating sprinklers on 80x80 ft sprinkler x lateral spacing.

Source

(lateral)Form II-1, item 10, p.29. Utah State University, Logan, Utah. https://pdf.usaid.gov/pdf_docs/PNAAG745.pdf

(traveler)Table 1, pg. 8. Evans, R.O., Barker J.C., Smith J.T., Sheffield R.E. 1997b. Field calibration procedures for animal wastewater application equipment, hard hose and cable tow traveler irrigation system. NC Cooperative Extension Service publication AG-553-2. Raleigh, NC.

(solid set)Work Sheet 1. p. 13. Evans, R.O., Barker J.C., Smith J.T., Sheffield R.E. 1997a. Field calibration procedures for animal wastewater application equipment, stationary sprinkler irrigation system. NC Cooperative Extension Service publication AG 553-1. Raleigh, NC.

References

Mirriam and Keller, 1978. Farm System Irrigation Evaluation: A Guide for Management. Form II-1, item 10, p.29. Utah State University, Logan, Utah. https://pdf.usaid.gov/pdf_docs/PNAAG745.pdf

Evans, R.O., Barker J.C., Smith J.T., Sheffield R.E. 1997b. Field calibration procedures for animal wastewater application equipment, hard hose and cable tow traveler irrigation system. NC Cooperative Extension Service publication AG-553-2. Raleigh, NC. https://content.ces.ncsu.edu/hard-hose-and-cable-tow-traveler-irrigation-systems

Evans, R.O., Barker J.C., Smith J.T., Sheffield R.E. 1997a. Field calibration procedures for animal wastewater application equipment, stationary sprinkler irrigation system. NC Cooperative Extension Service publication AG 553-1. Raleigh, NC. https://irrigation.wordpress.ncsu.edu/files/2017/01/ag-553-1-stationary-sprinkler.pdf

Examples

```
library(fields) # for easy grid construction
data(catchcan)
use.data<-catchcan$lateral #matrix can be viewed as plan view of catch data
#x,y matrix 10 ft x 10 ft catch can spacing
x<-seq(-35,25,10) # x=0 is lateral position
y<-seq(5,55,10)
grd<-list(x,y) # prepare list for make.surface function [fields]
grid<-make.surface.grid(grd)
plot(grid)
labels<-matrix(t(use.data),ncol=1)#transpose matrix and stack rows into 1 column
text(grid[ ,1],grid[ ,2]+2,labels,cex=0.8) # plot catch data at collection point

## or plot using function plotss.  Shows test data from 1 lateral with no overlap.
cdata<-cbind(grid[ ,1],grid[ ,2],labels) #construct required catch can data matrix
sp.x<-rep(0,3);sp.y<-seq(0,60,30)# sprinkler spacing (y) = 30 ft
sploc<-cbind(sp.x,sp.y) #construct required sprinkler location matrix
plotss(cdata,sploc)
```

CU *Compute CU for Sprinkler Irrigation Systems*

Description

Compute Christiansen Coefficient of Uniformity (CU or UC). Coefficient is based upon the deviations from the mean value.

Usage

```
CU(x)
```

Arguments

x

Value

CU value in percentage. Note that CU can take on a negative value if the average deviation from the mean is greater than the mean.

Author(s)

Garry Grabow <glgrabow@ncsu.edu>

References

Christiansen, J. E. 1942. Irrigation by sprinkling. California Agricultural Experiment Station Bulletin 670. Berkeley, Cal.: University of California.

Keller, J., and R. D. Bliesner. 2000. Sprinkler and Trickle Irrigation. Caldwell, N.J.: Blackburn Press

See Also

DU,DU.lh

Examples

```
# data below are volumes caught in ml.  Catch cans must be of
# equal surface area at top when using volume data
x<-c(47,42,45,24,13,26,33,34,27,30,40,44,32,12,12)
xcu<-CU(x)
#round results
curnd<-round(xcu,2)
xcu
curnd
```

DU *DU of sprinkler irrigation system*

Description

Computes DU (distribution uniformity of low half) for sprinkler systems using catch can data.

Usage

```
DU(x)
```

Arguments

x	numeric array of catch can data.

Author(s)

Garry Grabow <glgrabow@ncsu.edu>

References

Keller, J., and R. D. Bliesner. 2000. Sprinkler and Trickle Irrigation. Caldwell, N.J.: Blackburn Press

See Also

CU,DU.lh

Examples

```
# data below are volumes caught in ml.  Catch cans must be of
# equal surface area at top when using volume data
x<-c(47,42,45,24,13,26,33,34,27,30,40,44,32,12,12)
xdu<-DU(x)
#round results
durnd<-round(xdu,2)
xdu
durnd
```

DU.lh *Compute distribution uniformity of lower half*

Description

Computes uniformity of lower half of a solid set sprinkler system vs. lower quarter as does DU. Note that this computation uses the same method as low quarter, except it uses the observations of the low half rather than low quarter. It does not use an empirical equation that converts DU (low quarter) to DUlh (lower half) as some have proposed.

Usage

```
DU.lh(x)
```

Arguments

x	a numeric array of catch depths or volumes.

Value

DU of lower half value in percentage.

Author(s)

Garry Grabow <glgrabow@ncsu.edu>

See Also

CU,DU

Examples

```
# data below are volumes caught in ml.  Catch cans must be of
# equal surface area at top when using volume data
x<-c(47,42,45,24,13,26,33,34,27,30,40,44,32,12,12)
xdulh<-DU.lh(x)
#round results
dulhrnd<-round(xdulh,2)
xdulh
dulhrnd
```

`eda.shape` *Generate distribution plots of an array.*

Description

Generate histogram, boxplot, density, and quartile plots.

Usage

```
eda.shape(x,title="",qq=T)
```

Arguments

`x`	numeric array
`title`	character; optional title for plots
`qq`	logical; for plotting quartile plot, default=T

Details

This function is modified from the SPlus version of the same name, see references.

Value

Four plots on one page [mfrow = c(2, 2)]- histogram, boxplot, density, and quartile.

Author(s)

Garry Grabow <`glgrabow@ncsu.edu` >

References

TIBCO Spotfire S+ 8.2 2010. Guide to Statistics, v0l. 1, p.124ff

See Also

`eda.stats`,`hist`, `boxplot`,`density`, `qqnorm`

Examples

```
#generate and plot univariate normally distributed data
require(graphics)
x<-rnorm(25,1,0.25)
eda.shape(x,title="my normal data")
```

---

eda.stats *Summary statistics of a numeric array.*

Description

Generates summary statistics of mean, median, skew, kurtosis, min, max and quartiles.

Usage

```
eda.stats(x)
```

Arguments

x	numeric array

Details

requires timeDate library

Value

Named list with the following items:

summary	min, 1st quartile, median, mean, 3rd quartile, max
skew	skewness
kurt	kurtosis

Author(s)

Garry Grabow

See Also

eda.shape, summary,skewness, kurtosis

Examples

```
require(timeDate)
# summary statistics for random normal data
# mean of 1. sd = 0.3
ndata<-rnorm(25,1,.3)
eda.stats(ndata)
#summary statistics for right-skewed data
#mean of 1, sd=1
rdata<-rexp(25,rate=1)
eda.stats(rdata)
```

eff *Application efficiency and adequacy of a sprinkler irrigation system*

Description

determines amount of water above and below target depth to determine efficiency and adequacy from catch can data. If target depth is equal to soil moisture depletion in the root zone, all catch can depths greater than target are, in concept, lost to deep percolation and reduce efficiency, and all depths less than target are 100% efficient but reduce adequacy.

Usage

```
eff(x, target)
```

Arguments

`x`	numeric array of catch can depths
`target`	target depth

Details

computes efficiency and adequacy as amount of catch equal or less than target depth (efficiency is applied water retained in root zone divide by total water applied), and amount of catch equal or exceeding target depth (adequacy). Amounts obtained using results of a density (frequency) plot and normalized to target depth and reported in decimal (not percent) form.

Value

A named list with the following items:

`appeff`	application efficiency based on target depth, decimal
`appadeq`	application adequacy based on target depth, decimal

Note

If all catch can depths (and resultant density curve) are all below the target depth, the application efficiency is 100%. This assumes that the target depth is equal to the soil water deficit (or less). So deficit irrigations are likely to be 100% or near 100% efficient.

Author(s)

Garry Grabow <glgrabow@ncsu.edu>

See Also

adper

Examples

```
target<-3
# generate data with mean of target amount and high variability (non-uniformity)
x<-rnorm(25,3,1.75)
eff(x,target)
# generate data with mean of target amount and low varibility (uniformity)
xx<-rnorm(25,3,0.5)
eff(xx,target)
```

`overlap` *Superimpose catch can data*

Description

Simulate overlap from adjacent laterals using data from one lateral.

Usage

```
overlap(sl,sc,lcdata,rcdata)
```

Arguments

`sl`	lateral spacing.
`sc`	catch can spacing perpindicular to lateral.
`lcdata`	data from cans left of lateral; order is proximate to distal of lateral.
`rcdata`	data from cans right of lateral; order as in lcdata.

Details

Superimposes and sums one row of catch can data as if adjacent lateral had same catch pattern. Repeat function for multiple rows of catch cans between laterals, to normally include all rows of cans between two sprinklers.

Value

A named list with the following items:

`sum.left`	numeric array of summed overlap catch can data between tested lateral and simulated lateral to the left.
`sum.right`	numeric array of summed overlap catch can data between tested lateral and simulated lateral to the right.

Note

both items of list will have same summed values but in inversely ordered. Only can data receiving water need to be entered into lcdata and rcdata. The function will automatically produce "phantom cans" to fill between adjacent laterals if not entered and set catch to 0.

Author(s)

Garry Grabow <glgrabow@ncsu.edu>

Examples

```
sl<-60 #lateral spacing. Units are feet
sc<-10 #catch cans spacing along single "row". Units are feet
#note that neither lcdata or rcdata have 6 cans. function will generate "0" cans.
lcdata<-c(0.28,0.24,0.21,0.10)
rcdata<-c(0.23,0.21,0.3)
#generate summed catch for one row at 60 foot lateral spacing
spacing.60<-overlap(sl,sc,lcdata,rcdata)
spacing.60
#now generate summed catch assuming a 50 foot lateral spacing
sl<-50
spacing.50<-overlap(sl,sc,lcdata,rcdata)
spacing.50
```

PELQ — *Potential application efficiency of low quarter for a sprinkler irrigation system.*

Description

This function determines PELQ as the average of the low quarter catch rates divided by the average catch rate of applied water. As such is is a measure of the potential of the sprinkler irrigation system considering uniformity (low quarter) and any losses due to drift and evaporation (uses catch can rates).

Usage

```
PELQ(x,SI=TRUE,rate,ss,sl,dur)
```

Arguments

`x`	numeric array of catch can depths.
`SI`	logical; units SI (mm, m, lpm) or US Customary (in., ft, gpm). SI (TRUE) is default.
`rate`	sprinkler discharge rate (lpm or gpm).
`ss`	sprinkler spacing (m or ft).
`sl`	lateral spacing (m or ft).
`dur`	duration of irrigation event, hr.

Details

catch can depths converted to catch rates.

Value

PELQ (potential application efficiency of low quarter, %

Author(s)

Garry Grabow <glgrabow@ncsu.edu>

References

Mirriam and Keller, 1978. Farm System Irrigation Evaluation: A Guide for Management. PP 41-43. Utah State University, Logan, Utah. https://pdf.usaid.gov/pdf_docs/PNAAG745.pdf

See Also

PELQT,AELQ

Examples

```
#see pp 41-43 of reference document
SI<-FALSE # use U.S. customary units
x<-c(.23,.31,.24,.24,.28,.31,.27,.22,.26,.31,
.31,.25,.20,.22,.32)# catch can depths caught during test converted to in/hr
rate<-4.6 # 4.6 gpm sprinkler discharge rate (measured)
sl<-50; ss<-30 # 30 x 50 ft sprinkler x lateral spacing
dur<-1 # 1 hr test duration (dur. in min)
PELQ(x,SI=FALSE,rate,ss,sl,dur)
```

PELQT — *Potential application efficiency of low quarter for a traveling irrigation system.*

Description

This function determines PELQ as the average of the low quarter catch depths divided by the average catch depth of applied water. As such is is a measure of the potential of the sprinkler irrigation system considering uniformity (low quarter) and any losses due to drift and evaporation (uses catch can depths overlapped at specified lane spacing).

Usage

```
PELQT(x,SI=TRUE,rate,ls,ts)
```

Arguments

`x`	numeric array of catch can depths, overlapped.
`SI`	logical; units SI (mm, m, lpm) or US Customary (in., ft, gpm). SI (TRUE) is default.
`rate`	sprinkler discharge rate (lps or gpm).
`ls`	lane spacing (m or ft).
`ts`	travel speed (m/min or ft/min).

Details

catch can depths overlapped to specified lane spacing.

Value

PELQT (potential application efficiency of low quarter for traveling system, %

Author(s)

Garry Grabow <glgrabow@ncsu.edu>

References

Evans, R.O., Barker J.C., Smith J.T., Sheffield R.E. 1997b. Field calibration procedures for animal wastewater application equipment, hard hose and cable tow traveler irrigation system. NC Cooperative Extension Service publication AG-553-2. Raleigh, NC https://p2infohouse.org/ref/32/31084/ag-553-2.pdf

Liu, Z., G.L. Grabow, R.L. Huffman, J. Osborne, and R.O. Evans. 2012. Factors Affecting Uniformity of Irrigation-Type Manure Application Systems. Applied Eng. in Agric. 28(1):43-56.

Mirriam and Keller, 1978. Farm System Irrigation Evaluation: A Guide for Management. PP 97-107. Utah State University, Logan, Utah. https://pdf.usaid.gov/pdf_docs/PNAAG745.pdf

See Also

PELQ, travunif

Examples

```
#see pp 41-43 of reference document
SI<-FALSE # use U.S. customary units
left<-c(0.94,0.80,0.59,0.61,0.50,0.42,0.33,0.07)
right<-c(0.73,0.81,0.92,0.64,0.50,0.27,0.20,0.13)
ls<-224;gs<-20
#first call travunif to return overlapped data given gage spacing and lane spacing
out<-travunif(ls,gs,left,right)
x<-out$o.depths
rate<-197 # 197 gpm sprinkler discharge rate (measured)
PELQT(x,SI=FALSE,rate,ls,1.5)#call PELQ for traveling systems
```

---

plotss *Plot a plan view of sprinklers and catch cans with collected depths.*

Description

plots a densigram with optional contour plot of catch can depths, with an option to label points. Both contour and point labeling are invoked by default (TRUE).

Usage

```
plotss(cdata,sploc,con=TRUE, xlab="",ylab="",title="",labelpoints=TRUE,
imcol=FALSE,edastat=FALSE)
```

Arguments

cdata	n x 3 matrix of catch can data; 1st column x, 2nd column y can locations, 3rd column catch depths
sploc	n x 2 matrix of sprinkler location data; 1st column xi, second column yi. i=4 for 4 sprinklers with cans in-between.

con	Logical; TRUE to overlay contour plot on densigram, default is TRUE
xlab	label for x axis of plot
ylab	label for y axis of plot
title	main title for plot, default is FALSE (no title)
labelpoints	logial; plot amounts at can locations? Default is TRUE.
imcol	logical; color densigram? Default is FALSE for grey-scale.
edastat	call eda.stat function for stats on catch depths? Default is FALSE.

Value

densigram (from `interp` with optional contour plot overlay) and optional summary catch can statistics.

Note

requires akima package

Author(s)

Garry Grabow <glgrabow@ncsu.edu>

See Also

`interp`

Examples

```
# set sprinkler locations (ft here)
sprinklerx<-c(0,0,60,60)
sprinklery<-c(60,0,60,0)
sploc<-cbind(sprinklerx,sprinklery)
#construct can data matrix
gage.space<-15
x<-c(rep(7.5,4),rep(22.5,4),rep(37.5,4),rep(52.5,4))
y<-rep(seq(52.5,7.5,-gage.space),4)
depth<-c(0.3,0.32,0.26,0.26,0.16,0.32,0.14,0.41,
0.14,0.27,0.38,0.34,0.29,0.32,0.45,0.25)
cdata<-cbind(x,y,depth)
plotss(cdata,sploc,xlab="ft",ylab="ft")
```

---

quart *Compute several levels of quantiles and interquartile range*

Description

generates quantiles at 0.1, 1,5,10-90, 95, 99, 99,9 percentiles.

Usage

```
quart(x)
```

Arguments

`x`	numeric array

Value

named list with following items:

`q`	quantiles at 0.1, 1,5,10-90, 95, 99, 99,9 percentiles
`d`	interquartile range - i.e., 75th quantile minus 25th quantile

Author(s)

Garry Grabow `<glgrabow@ncsu.edu>`

See Also

`eda.stats`

Examples

```
# quantiles for random normal data
x<-rnorm(25,10,1)
xn<-quart(x)
```

`rotecdf` *Swap axis of ecdf plot and reverse y axis*

Description

plots points generated from an ecdf object with x and y axis swapped (x is cummulative freqency) and with y axis reversed so that min(y)=0 is at top. Plots points without step function lines.

Usage

```
rotecdf(x,target,ylab)
```

Arguments

`x`	numeric array
`target`	target, a constanst, e.g., target depth of irrigation. Default is NA.
`ylab`	label for y axis, e.g. depth applied. Default is object name of x if not supplied.

Details

A minimum y of 0 is forced such that the plot can be interpreted at 0 being ground surface. If "target" is supplied, a horizontal line at the value of target is drawn. Points and area below the target line indicate water applied in excess of the target amount.

Value

rotated ecdf plot.

Author(s)

Garry Grabow <glgrabow@ncsu.edu>

See Also

sfplot

Examples

```
target<-3
# generate data with mean of target amount and high variability (non-uniformity)
x<-rnorm(25,3,1.75)
rotecdf(x,target,ylab="depth applied (caught)")
# generate data with mean of target amount and low varibility (uniformity)
xx<-rnorm(25,3,0.5)
rotecdf(xx,target)#no y axis label provided - defaults to array object name
```

---

sfplot *Create step function plot.*

Description

Uses an ecdf object to plot a step function plot with cumulative frequency on x axis and input array on y axis with y-axis reversed (min(y)= 0 at top of y-axis).

Usage

```
sfplot(x,target,ylab)
```

Arguments

x	numeric array
target	target, e.g., depths from catch cans. Default is NA.
ylab	label for y axis, e.g. depth applied. Default is object name of x if not supplied.

Details

Plot includes step function lines unlike rotecdf. A minimum y of 0 is forced such that the plot can be interpreted as 0 being ground surface. If "target" is supplied, a horizontal line at the value of target is drawn. Points and area below the target line indicate water applied in excess of the target amount.

Value

Step function plot as empirical cumulative distribution function with x on y-axis and f(x), i.e., cum. prob., on x-axis.

Author(s)

Garry Grabow <glgrabow@ncsu.edu>

See Also

rotecdf,stepfun

Examples

```
target<-3
# generate data with mean of target amount and high variability (non-uniformity)
x<-rnorm(25,3,1.75)
sfplot(x,target,ylab="depth applied (caught)")
# generate data with mean of target amount and low varibility (uniformity)
xx<-rnorm(25,3,0.5)
sfplot(xx,target)#no y axis label provided - defaults to array object name
```

---

travunif *Compute CU and DU of traveling gun irrigation systems*

Description

This function computes 3 values of sprinkler irrigation distribution uniformity - CU (Christiansen's coefficient of uniformity), DU (dist. unif. of low quarter), DU.lh (dist. unif. of low half) for traveling gun irrigation systems. Data from a single transect of catch cans from one hard hose pull is used, and data is overlapped to account for additional contribution from adjacent traveler pulls. Overlapped catch depths are also returned.

Usage

```
travunif(ls,cs,lcdata,rcdata,site="",plot=T)
```

Arguments

`ls`	lane spacing.
`cs`	catch can spacing.
`lcdata`	catch can data from cans left of hose - order is from closet to hose outward.
`rcdata`	catch can data from cans right of hose - order is from closet to hose outward.
`site`	optional character label for location (site) of evaluation - used in plot titles.
`plot`	logical argument to invoke plotting, default is TRUE.

Details

It is not necessary that lcdata and rcdata be of equal length. This might occur if windy conditions prevail and the wetted width of one side is greater than antother, and data is not entered for empty cans. The function will automatically assign 0 depths to the "missing" catch cans if not explicity done. While using volume instead of depth data will result in the same unformity values, depth is more intuitive and will be required if the ‘o.depths‘ output will be used to compute ‘PELQT‘.

Value

A named list with the following items:

o.depths	collected depths as overlapped within travel lane
CU	CU from catch can data with overlap from adjacent lanes
DUlh	DU low half (using function DU.lh) from catch can data with overlap from adjacent lanes
DU	DU from catch can data with overlap from adjacent lanes

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References

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Liu, Z., G.L. Grabow, R.L. Huffman, J. Osborne, and R.O. Evans. 2012. Factors Affecting Uniformity of Irrigation-Type Manure Application Systems. Applied Eng. in Agric. 28(1):43-56.

See Also

PELQT

units can be SI or US Customary, e.g. # SI - mm for catch can data and m for lane and catch # can spacing # U.S. cust. - in. for catch can data and ft for lane # and catch can spacing left<-c(0.17,0.22,0.18,0.21,0.13,0.05,0.02,0) # units are in. right<-c(0.16,0.2,0.21,0.2,0.21,0.13,0.06,0.02) ls<-165;gs<-16 # units are ft travunif(ls,gs,left,right)

Index