

Package ‘EmiStatR’

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Type Package

Title Estimation of Wastewater Emissions in Combined Sewer Systems

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Description The EmiStatR provides a fast and parallelised calculator to estimate combined wastewater emissions.

It supports the planning and design of urban drainage systems, without the requirement of extensive simulation tools. The EmiStatR package implements modular R methods. This enables to add new functionalities through the R framework. Furthermore, EmiStatR was implemented with an interactive user interface with sliders and input data exploration.

License GPL (>= 3)

Depends methods, foreach, parallel, doParallel, lattice, shiny

NeedsCompilation yes

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EmiStatR-package

Estimation of Wastewater Emissions in Combined Sewer Systems.

Description

The EmiStatR provides a fast and parallelised calculator to estimate combined wastewater emissions. It supports the planning and design of urban drainage systems, without the requirement of extensive simulation tools. The EmiStatR package implements modular R methods. This enables to add new functionalities through the R framework. Furthermore, EmiStatR was implemented with an interactive user interface with sliders and input data exploration.

Details

The DESCRIPTION file:

```
Package:   EmiStatR
Type:      Package
Version:   1.2.0
Date:      2016-07-22
License:   GPL (>= 3)
Depends:   R (>= 2.10), methods, foreach, parallel, doParallel, lattice, shiny
```

Author(s)

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See Also

See also the class the method [EmiStatR](#)

EmiStatR-methods

S4 Methods for Function EmiStatR

Description

S4 methods for function EmiStatR. Given the inputs either from the Shiny applications "EmiStatR_input - Shiny" and "EmiStatR_inputCSO - Shiny" or user-defined, the methods invoke the main core of the tool and writes the output files in the specified folder.

Usage

EmiStatR(x)

Arguments

x An object of class input

Value

Object of class "list". This object contains N lists, where N is the number of structures to simulate. Each list contains a list with three elements: a data.frame named "out1", a data.frame named "out2", a vector named "lista". "out1" contains n observations of 21 variables, where n is the length of the precipitation time series. The 21 variables are the following time series:

1. id, identification number
2. Time [y-m-d h:m:s]
3. P [mm], precipitation
4. i [mm/(min)], intensity (if available)
5. V_r [m3], rain water volume
6. V_dw [m3], dry weather volume
7. cs_mr [-], combined sewage mixing ratio
8. o_tfyn [yes=1/no=0], status variable to know when the Combined Sewer Overflow Tank (CSOT) is filling up
9. V_Tank [m3], volume of CSOT filling up
10. V_Ov [m3], overflow volume
11. B_COD_Ov [kg], Chemical Oxygen Demand (COD) overflow load
12. B_NH4_Ov [kg], ammonium (NH4) overflow load
13. C_COD_Ov [mg/l], COD overflow concentration
14. C_NH4_Ov [mg/l], NH4 overflow concentration
15. d_Ov [min], total duration of overflows
16. f_Ov [occurrence], frequency of overflows (just an approximation)
17. V_InTank [m3], volume at entrance of the CSOT
18. B_COD_InTank [Kg], COD load at entrance of the CSOT
19. B_NH4_InTank [Kg], NH4 load at entrance of the CSOT
20. C_COD_InTank [mg/l], COD concentration at entrance of the CSOT
21. C_NH4_InTank [mg/l], NH4 concentration at entrance of the CSOT

The summary of the overflow data, "out2", contains 11 observations of 2 variables. The 11 observations are:

1. Period [day], length of time of the precipitation time series
2. Duration, d_Ov, [min], overflow duration
3. Frequency, f_Ov, [occurrence] (aprox.), overflow frequency
4. Volume, V_Ov, [m3], total overflow volume
5. Flow, Q_Ov, [l/s], total overflow flow
6. COD load, B_COD_Ov, [kg], total COD load
7. Average COD concentration, C_COD_ov_av, [mg/l], in overflows
8. Maximum COD concentration, C_COD_Ov_max, [mg/l], in overflows
9. NH4 load, B_NH4_Ov, [kg], total NH4 load
10. Average NH4 concentration, C_NH4_Ov_av, [mg/l], in overflows
11. Maximum NH4 concentration, C_NH4_Ov_max, [mg/l], in overflows

"Lista" contains the identification name(s) of the N structure(s). If export is allowed then three plain text .csv files are created, one for "out1", the second for "out2", the third one a summary for

all the structures based in "out2". Also, one .pdf file is printed which illustrates the precipitation and Combined Sewer Overflow (CSO) volume, COD concentration, and NH4 concentration time series. These files are exported to the directory EmiStatR_output located in the folderOutput path.

Methods

signature(x = "input") execute EmiStatR function

Examples

```
## running GUI
library("EmiStatR")

appDir <- system.file("shiny", package = "EmiStatR")
setwd(appDir)

## (uncomment for running)
# runApp("EmiStatR_input")
# runApp("EmiStatR_inputCSO")

## executing EmiStatR
input.default <- input()
sim <- EmiStatR(input.default)

str(sim)

## a dummy example of plot
par(mfrow=c(2,2), oma = c(0,0,2,0))
plot(x=sim[[1]][[1]][[2]], y=sim[[1]][[1]][[3]], typ="l", col="blue",
      xlab = "time", ylab = colnames(sim[[1]][[1]])[3], main = "Precipitation")
plot(x=sim[[1]][[1]][[2]], y=sim[[1]][[1]][[10]], typ="l", col="blue",
      xlab = "time", ylab = colnames(sim[[1]][[1]])[10], main = "CSO, volume")
plot(x=sim[[1]][[1]][[2]], y=sim[[1]][[1]][[13]], typ="l", col="blue",
      xlab = "time", ylab = colnames(sim[[1]][[1]])[13], main = "CSO, COD concentration")
plot(x=sim[[1]][[1]][[2]], y=sim[[1]][[1]][[14]], typ="l", col="blue",
      xlab = "time", ylab = colnames(sim[[1]][[1]])[14], main = "CSO, NH4 concentration")
mtext(paste("Structure", sim[[1]][[3]][[1]]), outer=TRUE, cex = 1.5)
```

Description

This dataset is a data.frame with two columns: Time [y-m-d h:m:s] and Precipitation P [mm]. The station of measuring, Esch Sure, is located close to the catchment of the combined sewer overflow tank at Goesdorf, Grand-Duchy of Luxembourg.

Usage

```
data("Esch_Sure2010")
```

Format

A data frame with 52560 observations on the following 2 variables.

time a POSIXct

'P [mm]' a numeric vector

Examples

```
data(Esch_Sure2010)
```

```
plot(Esch_Sure2010[,1], Esch_Sure2010[,2], col="blue", typ="l",
      xlab = "time", ylab = "Precipitation [mm]")
```

input-class	<i>Class "input"</i>
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Description

The class provides a container for inputs required to invoke EmiStatR method.

Objects from the Class

Objects can be created by calls of the form `input()` or `new("input")`.

Slots

spatial: Object of class "numeric", 0 (default) for non-spatial input, 1 for spatial input (not implemented).

zero: Object of class "numeric", approximation to zero value. Default 1E-5.

folder: Object of class "character", path of the Shiny applications. Default `system.file("shiny", package = "EmiStatR")`

folderOutput: Object of class "character", path of the directory to save outputs. By default the same as folder.

cores: Object of class "numeric", number of CPU cores to be used in parallel computing. If cores = 0 no parallel computation is done. Default 1.

ww: Object of class "list". This list contains three numeric elements for the wastewater characteristics. First element `qs`, individual water consumption of households [l/(PE d)]. Second element `CODs`, sewage pollution - COD concentration [g/(PE d)]. Third element `NH4s`, sewage pollution - NH4 concentration [g/(PE d)].

inf: Object of class "list". This list contains three numeric elements for infiltration water characteristics. First element `qf`, infiltration water inflow [l/(s ha)]. Second element `CODf`, infiltration water pollution - COD concentration [g/(PE d)]. Third element `NH4f`, infiltration water pollution - NH4 concentration [g/(PE d)].

- rw:** Object of class "list". This list contains three elements for rainwater characteristics. First element CODr (numeric), rainwater pollution - COD concentration [mg/l]. Second element NH4r (numeric), rainwater pollution - NH4 concentration [mg/l]. Third element stat (character), name of the rain measurement station.
- tf:** Object of class "numeric", stormwater runoff. Flow time in the sewer system [min]. If tf is less or equal than 20 min, then af = 1, i.e. no attenuation of the rainfall.
- P1:** Object of class "data.frame" with columns named tt (date and time), P (rain time series), and i (intensity).
- st:** Object of class "list". This object contains n lists, where n is the number of structures to simulate. Every list should contain 12 elements: id, identification number [-]; ns, name of the structure [-]; nm, name of the municipality [-]; nc, name of the catchment [-]; numc, number of the catchment [-]; use, use of the soil [-]; Ages, total area [ha]; Ared, reduced area - impervious area [ha]; tfS, time flow structure [min]; pe, population equivalent [PE]; Qd, throttled outflow [l/s]; and V, volume [m3].
- export:** Object of class "numeric". If 1 (default) then the results are saved in folderOutput. Set to 0 for not writing in output files.

Methods

EmiStatR signature(x = "input"): execute EmiStatR function

Author(s)

J.A. Torres-Matallana

Examples

```
showClass("input")

## running EmiStatR with default input
library("EmiStatR")

# creating an Input object
input.default <- new("input")
str(input.default)

# running EmiStat
sim1 <- EmiStatR(input.default)

## running EmiStatR with user defined input
data("P1")

# defining estructures E1 and E2
E1 <- list(id = 1, ns = "Goesdorf", nm = "Goesdorf", nc = "Obersauer", numc = NA,
  use = "Residencial/Industrial", Ages = 16.5, Ared = 7.6, tfS = 10,
  pe = 611, Qd = 9, V = 190)

E2 <- list(id = 2, ns = "Kaundorf", nm = "Kaundorf", nc = "Obersauer", numc = NA,
  use = "Residencial/Industrial", Ages = 22, Ared = 11, tfS = 10,
  pe = 358, Qd = 9, V = 180)
```

```
# defining Input objet
input.user <- input(spatial = 0, zero = 1e-5, folder = system.file("shiny", package = "EmiStatR"),
                  folderOutput = system.file("shiny", package = "EmiStatR"), cores = 1,
                  ww = list(qs = 150, CODs = 120, NH4s = 11),
                  inf = list(qf= 0.05, CODf = 0, NH4f =0),
                  rw = list(CODr = 107, NH4r = 0, stat = "Dahl"),
                  tf = 20, P1 = P1,
                  st = list(E1=E1, E2=E2), export = 1)

str(input.user)

# invoking EmiStatR
sim2 <- EmiStatR(input.user)
```

P1

An example time series for the EmiStatR package

Description

This dataset is a list that contains a data.frame with two columns: Time [y-m-d h:m:s] and Precipitation P [mm]. The station of measuring, Dahl, is located close to the catchment of the combined sewer overflow tank at Goesdorf, Grand-Duchy of Luxembourg.

Usage

```
data("P1")
```

Format

A data frame with 4464 observations on the following 2 variables.

time a POSIXct

‘P [mm]’ a numeric vector

Source

<http://agrimeteo.lu/>

Examples

```
data("P1")
```

```
plot(P1[,1], P1[,2], col="blue", typ="l", xlab = "time", ylab = "Precipitation [mm]")
```

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