

Package: outfloweR (via r-universe)

October 4, 2026

Encoding UTF-8
Type Package
Title Simulation of Reservoir Mass Balance
Version 0.4-2
Date 2025-06-28
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Description A demonstration of reservoir level and stratification management, based on simple mass balances.
Depends R (>= 4.1.0), deSolve, ggplot2
Imports stats, graphics, utils, shiny, dplyr, tidyr, ggpubr, shinyjs, rlang, purrr, shiny.i18n
Suggests knitr, rmarkdown, quarto
License GPL (>= 2)
VignetteBuilder quarto
RoxygenNote 7.3.2
URL <https://tpetzoldt.github.io/outfloweR/>
Config/pak/sysreqs cmake make libicu-dev libuv1-dev zlib1g-dev
Repository <https://tpetzoldt.r-universe.dev>
Date/Publication 2025-06-30 09:22:49 UTC
RemoteUrl <https://github.com/tpetzoldt/outfloweR>
RemoteRef HEAD
RemoteSha 7e36f0656d6ffdda5c9b16b6fe2bbc13a21a6293

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outfloweR-package	<i>Simulation of Reservoir Mass Balance</i>
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Description

The package aims to demonstrate reservoir management options by abstracting water either from the bottom outlet or the surface layer (the epilimnion). It uses a simple mass-balance approach and provides a shiny-app.

Author(s)

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References

ATT-Schriftenreihe Bd. 7: Integrale Bewirtschaftung von Trinkwassertalsperren gemäß DIN 19700. Siegburg, 2009.

See Also

Useful links:

- <https://tpetzoldt.github.io/outfloweR/>

approx_flows	<i>approx_flows</i>
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Description

approx_flows

Usage

```
approx_flows(time, in_E, out_E, in_H, out_H, wb_E, wb_H)
```

Arguments

time	numeric
in_E	numeric
out_E	numeric
in_H	numeric
out_H	numeric
wb_E	numeric
wb_H	numeric

areaFunction	<i>Hypsographic Functions for Conical Lake Geometry</i>
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Description

The functions calculate area resp. volume of a lake with a conical depth profile.

Usage

```
areaFunction(level, zmax, amax)

volumeFunction(level, zmax, amax)

vol2level(vol, zmax, amax)
```

Arguments

level	vector of water level above ground
zmax	maximum lake depth
amax	surface area of the lake surface for level = zmax
vol	vector of given volume(s)

Examples

```
level <- seq(0, 50, 1)
amax  <- 9e6
zmax  <- 50
area  <- areaFunction(level, zmax, amax)
vol   <- volumeFunction(level, zmax, amax)
plot(vol, cumsum(area), type="l")
(vol - cumsum(area)) / vol
```

discharge_dry

Data set discharge_dry

Description

Example Hydrological Data of d Dry Year

Example data sets with inflow and outflow of a reservoir (in Mio m³/d) of a normal, a wet and a dry year.

Format

Data frame with the following columns:

time time in days

inflow water inflow

outflow managed outflow, e.g. for drinking water supply

outflow_wb outflow to the river bed

Source

Lukas Gunzelmann, derived from real measurements

Examples

```
data("discharge_dry")
```

discharge_normal	<i>Data set discharge_normal</i>
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Description

Example Hydrological Data of d Normal Year

Example data sets with inflow and outflow of a reservoir (in Mio m3/d) of a normal, a wet and a dry year.

Format

Data frame with the following columns:

time time in days

inflow water inflow

outflow managed outflow, e.g. for drinking water supply

outflow_wb outflow to the river bed

Source

Lukas Gunzelmann, derived from real measurements

Examples

```
data("discharge_normal")
```

```
plot(inflow ~ time, data = discharge_normal, type="l", ylim=c(0, 1.5))  
lines(outflow ~ time, data = discharge_normal, col="blue")  
lines(outflow_wb ~ time, data = discharge_normal, col="green")
```

discharge_summerflood	<i>Inflow and Outflow Data</i>
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Description

Example data sets with inflow and outflow of a reservoir (in Mio m3/d) of a theoretical year with a high flood in summer.

Format

Data frame with the following columns:

time time in days

inflow water inflow

outflow managed outflow, e.g. for drinking water supply

outflow_wb outflow to the river bed

Source

Lukas Gunzelmann, derived from real measurements

Examples

```
data("discharge_summerflood")
```

discharge_wet	<i>Data set discharge_wet</i>
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Description

Example Hydrological Data of d Wet Year

Example data sets with inflow and outflow of a reservoir (in Mio m³/d) of a normal, a wet and a dry year.

Format

Data frame with the following columns:

time time in days

inflow water inflow

outflow managed outflow, e.g. for drinking water supply

outflow_wb outflow to the river bed

Source

Lukas Gunzelmann, derived from real measurements

Examples

```
data("discharge_wet")
```

flower	<i>Launch outfloweR shiny App</i>
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Description

Launch a shiny app to visualize mass balance of reservoirs.

Usage

```
flower(...)
```

Arguments

... optional parameters passed to the app (not yet implemented)

Details

The app is still experimental.

Value

This function has no return value.

Examples

```
## Not run:  
flower()  
  
## End(Not run)
```

hypso	<i>Data set hypso</i>
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Description

Example of a Hypsographic Table

hypso_bautzen	<i>Data set hypso_bautzen</i>
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Description

Hypsographic Table of Bautzen Reservoir

References

<http://www.tu-dresden.de/hydrobiologie>

hypso_cone

*Hypsographic Table of a Conic Lake***Description**

Hypsographic Table of a Lake with Conical Morphometry

Source

Generated data, see example below.

References

Sachse, R., Petzoldt, T., Blumstock, M., Moreira, S., Pätzig, M., Rücker, J., Janse, J. H., Mooij, W. M., Hilt, S. (2014). Extending one-dimensional models for deep lakes to simulate the impact of submerged macrophytes on water quality. *Environmental Modelling and Software*, 61, 410-423

Hrbáček, J. (1966). A morphometrical study of some backwaters and fish ponds in relation to the representative plankton samples (with an appendix by C. O. Junge on depth distribution for quadric surfaces and other configurations). *Hydrobiological Studies*, 1, 221–257.

Examples

```

zmax  <- 20                                # maximum depth (m)
area  <- function(Amax, zmax, z){Amax * (1 - (z)/zmax)^2}
volume <- function(Amax, zmax, z){Amax * zmax/3 * (1 - z/zmax)^3}
Amax  <- 12.07 * 1000 * 1000              # total Area (m^2)
depth <- seq(zmax, 0, -.1)                # depth (m)

hypso_cone <- data.frame(depth = depth,
  volume = volume(Amax, zmax, depth),
  area=area(Amax, zmax, depth)
)

## inverted depth order
hypso_cone$level <- zmax - hypso_cone$depth

```

hypso_functions

*Hypsographic Functions from Tabular Interpolation***Description**

The main function creates a function list object from a data table to allow interpolation of depths, areas and volume fractions of layers.

Usage

```
hypso_functions(table)
```

Arguments

table	hypso-graphic table (bathymetry) given as data frame with columns level, area and volume
-------	--

Value

a list of functions with the following elements (slots):

- `level(volume)` interpolates level from volume
- `volume(level)` interpolates volume from a given water level
- `area(level)` interpolates area from a given level
- `vh(level, zmixreal)` calculates hypolimnic volume from surface water level (m above ground) and mixing depth (zmixreal, thermocline in m below surface)
- `ve(level, zmixreal)` calculates epilimnic volume from surface water level and zmixreal
- `zmx(level, zmixreal)` calculates average mixing depth (zmx) from surface water level and zmixreal
- `zhm(level, zmixreal)` calculates average depth of bottom layer (hypolimnion and metalimnion)
- `sediment_area(level)` calculates sediment area for a series of water levels, where level should be a vector of water levels in ascending order
- `pelagic_ratio(level)` calculates the area ratio of the pelagic part (water) to the total area of layers. It is equal to 1 - sediment area fraction.

See Also

[hypso_bautzen](#), an example of a hypso-graphic table
[areaFunction](#), functions to create a hypso-graphic table for lakes with conical shape.

Examples

```
data(hypso_bautzen)           # load data table
hypso <- hypso_functions(hypso_bautzen) # create function object

hypso$volume(166)              # volume at 166 m a.s.l.
hypso$sediment_area(c(160, 166)) # sediment area of hypo- and epilimnion
```

plot_flows	<i>plot_flows</i>
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Description

plot_flows

Usage

```
plot_flows(
  discharge,
  xlab = "Tag im Jahr",
  ylab_inflow = "Zufluss (m3/d)",
  ylab_outflow = "Rohwasserabgabe (m3/d)",
  ylab_wildbed = "Wildbettabgabe (m3/d)"
)
```

Arguments

discharge	A data frame containing discharge data (must have ‘time‘, ‘inflow‘, ‘outflow‘, ‘outflow_wb‘ columns).
xlab	Label for the x-axis for all plots.
ylab_inflow	Label for the y-axis of the inflow plot.
ylab_outflow	Label for the y-axis of the raw water outflow plot.
ylab_wildbed	Label for the y-axis of the wild bed outflow plot.

Value

A combined ggplot object using ‘ggpubr::ggarrange‘.

plot_volumes	<i>plot_volumes</i>
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Description

plot_volumes

Usage

```
plot_volumes(
  out,
  xlab = "Tag im Jahr",
  ylab = "Volumen (Mio m3)",
  legend_title = "Teilraum",
  legend_labels = c("Epilimnion", "Hypolimnion")
)
```

Arguments

out	output from 'ode' (deSolve Object).
xlab	Label for the x-axis.
ylab	Label for the y-axis.
legend_title	Title for the legend.
legend_labels	Labels for the legend entries (corresponding to Epilimnion and Hypolimnion).

Value

A ggplot object.

scenario	<i>Run scenarios of a reservoir mass balance model</i>
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Description

Run scenarios of a reservoir mass balance model

Usage

```
scenario(
  option = c("standard", "cold_inflow", "wb_top"),
  vol,
  t_strat,
  t_autumn,
  inflow,
  outflow,
  outflow_wb
)
```

Arguments

option	character, specifying the water inflow and water abstraction regime
vol	numeric value, volume of the reservoir (in Mio m3)
t_strat	numeric value, day of stratification onset
t_autumn	numeric value, end of stratification
inflow	numeric vector, inflow in Mio m3/d
outflow	numeric vector, outflow in Mio m3/d
outflow_wb	numeric vector, bottom outlet in Mio m3/d

stratification_event	<i>stratification_event</i>
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Description

stratification_event

Usage

stratification_event(time, y, parms, inflows)

Arguments

time	numeric
y	numeric
parms	numeric
inflows	list

volume_model	<i>volume_model</i>
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Description

volume_model

Usage

volume_model(time, y, parms, inflows, ...)

Arguments

time	numeric
y	numeric
parms	numeric
inflows	list
...	not used

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