Package 'piragua'

November 6, 2025

Title Streamflow and Trend Analysis Tools for the PIRAGUA Project

Version 0.1.0

Description Functions to compute streamflow indicators, perform trend analyses, and generate graphical summaries for observed and modelled data in the Pyrenean region. Includes routines for annual and monthly summaries, trend estimation (Yue-Pilon method), and automated plotting.

License `use_mit_license()`

Encoding UTF-8

LazyData true

Roxygen list(markdown = TRUE)

RoxygenNote 7.3.2

Depends R (>= 4.1)

Imports abind,
dplyr,
evd,
ggplot2,
gridExtra,
ismev,
kableExtra,
lubridate,
dplyr,
magrittr,
scales,
sp,
xts,
zoo,
zyp

Suggests knitr,
rmarkdown,
usethis,
devtools

VignetteBuilder knitr

Contents

`anzanigo` *Daily streamflow at Gállego River at Anzánigo (station 2203)*

Description

Daily discharge series used as an example in the PIRAGUA vignettes. The station is located in the central Spanish Pyrenees and forms part of the Ebro basin gauging network.

Usage

```
anzanigo
```

Format

An xts / zoo object with 24106 rows and 2 variables:

Index Date of observation (class `Date`).

anzanigo Daily mean discharge ($m^3\ s^{-1}$).

Source

Confederación Hidrográfica del Ebro (CHE), processed within the PIRAGUA project.

Examples

```
data(anzanigo)
str(anzanigo)
plot(anzanigo$date, anzanigo$q, type = "l")
```

`piragua_annual` *Computes a set of streamflow statistics at the annual scale.*

Description

Computes a set of streamflow statistics at the annual scale.

Usage

```
piragua_annual(x, variable = "q", area = NULL)
```

Arguments

x	A univariate xts object, organized assuming a hydrological year.
area	Optional. A scalar, indicating the catchment area in km^2. mm (l m-2); otherwise, in m^3 s^-1. Applies only to streamflow (i.e., if var='q').
var	String. Name of the variable to analyise: one of 'q' (streamflow), 'pcp' (precipitation), 'tmp' (temperature).

Value

A multivariate xts object with the following columns corresponding to streamflow / precipitation indices:

year the year for which the statistics are computed; note that hydrological years (from previous october to september) are used

mean mean daily streamflow (m3 s-1 / mm)

sd standard deviation of daily streamflow (m3 s-1 / mm)

max maximum daily value

min minimum daily value

q10 10th percentile of daily streamflow (m3 s-1 / mm)

q25 25th percentile of daily streamflow (m3 s-1 / mm)

q50 50th percentile of daily streamflow (median) (m3 s-1 / mm)

q75 75th percentile of daily streamflow (m3 s-1 / mm)

q90 90th percentile of daily streamflow (m3 s-1 / mm)

iqr inter-quartile range (q75-q25) (m3 s-1 / mm)

uqr upper-quartile range (q75-q50) (m3 s-1 / mm)

lqr lower-quartile range (q50-q25) (m3 s-1 / mm)

qsk quantile skewness, >0 for right skewness ((uqr-lqr)/iqr) (-) -1, 1

idr inter-decile range (q90-q10) (m3 s-1 / mm)

dsk decile skewness, >0 for right skewness ((q90-q50)-(q50-q10))/(q90-q10)) (-) -1, 1

dku decile kurtosis, >0 for ((q90-q10))/(q70-q25)) (-)

n_q10 number of days below the 10th percentile of the whole series

n_q25 number of days below the 25th percentile of the whole series

n_q50 number of days above the 50th percentile of the whole series

n_q75 number of days above the 75th percentile of the whole series

n_q90 number of days above the 90th percentile of the whole series

v_q10 volume of steamflow below the 10th percentile of the whole series (hm3 / mm)

v_q25 volume of steamflow below the 25th percentile of the whole series (hm3 / mm)

v_q50 volume of steamflow above the 50th percentile of the whole series (hm3 / mm)

v_q75 volume of steamflow above the 75th percentile of the whole series (hm3 / mm)

v_q90 volume of steamflow above the 90th percentile of the whole series (hm3 / mm)

rl20 streamflow corresponding to a 20-years return period (m3 s-1 / mm)

n number of days with data

na number of days with missing data

na_5 number of periods of 5 consecutive days with missing data

For variable q the following indices are also computed: #'

vcn3 baseflow index: daily minimum streamflow averaged over 3 consecutive days (m3 s-1 / mm)

vcn7 baseflow index: daily minimum streamflow averaged over 7 consecutive days (m3 s-1 / mm)

For variable pcp the following indices are also computed: #'

nrainy number of rainy days

total total rain (mm)

meanrainy mean precipitation of rainy days (mm day-1)

sdrainy standard deviation of precipitation of rainy days (mm day-1)

References

NA

Examples

```
# Example 1 (not run)
# annual <- piragua_annual(datt[,1])
# annual <- piragua_annual(datt[,1], area=1000)
```

`piragua_monthly` *Computes a set of streamflow statistics at the monthly scale.*

Usage

```
piragua_monthly(x, variable = "q", area = NULL)
```

Arguments

`x`	A univariate `xts` object, organized assuming a hydrological year.
`area`	Optional. A scalar, indicating the catchment area in km^2. If an area is provided, the resulting values are given in mm (l m-2); otherwise, in m^3 s^-1. Applies only to streamflow data (`var='q'`).
`var`	String. Name of the variable to analyise: one of 'q' (streamflow), 'pcp' (precipitation), 'tmp' (temperature).

Value

A multivariate `xts` object with the following columns:

year the year for which the statistics are computed; note that hydrological years (from previous october to september) are used

month the month for which the statistics are computed

mean mean daily streamflow (m3 s-1 or mm)

max maximum daily value

min minimum daily value

sd standard deviation of daily streamflow (m3 s-1 or mm)

q10 10th percentile of daily streamflow (m3 s-1 or mm)

q25 25th percentile of daily streamflow (m3 s-1 or mm)

q50 50th percentile of daily streamflow (median) (m3 s-1 or mm)

q75 75th percentile of daily streamflow (m3 s-1 or mm)

q90 90th percentile of daily streamflow (m3 s-1 or mm)

iqr inter-quantile range (q75-q25) (m3 s-1 or mm)

uqr upper-quartile range (q75-q50) (m3 s-1 / mm)

lqr lower-quartile range (q50-q25) (m3 s-1 / mm)

qsk quantile skewness, >0 for right skewness ((uqr-lqr)/iqr) (-) -1, 1

dku decile skewness, >0 for right skewness ((q90-q50)-(q50-q10))/(q90-q10)) (-) -1, 1

n_q10 number of days below the 10th percentile of the whole series

n_q25 number of days below the 25th percentile of the whole series

n_q50 number of days above the 50th percentile of the whole series

n_q75 number of days above the 75th percentile of the whole series

n_q90 number of days above the 90th percentile of the whole series

v_q10 volume of steamflow below the 10th percentile of the whole series (hm3 or mm)

v_q25 volume of steamflow below the 25th percentile of the whole series (hm3 or mm)

v_q50 volume of steamflow above the 50th percentile of the whole series (hm3 or mm)

v_q75 volume of steamflow above the 75th percentile of the whole series (hm3 or mm)

v_q90 volume of steamflow above the 90th percentile of the whole series (hm3 or mm)

n number of days with data

na number of days with missing data

na_3 number of periods of 3 consecutive days with missing data For variable q the following indices are also computed: #'

vcn3 baseflow index: daily minimum streamflow averaged over 3 consecutive days (m3 s-1 / mm)

vcn7 baseflow index: daily minimum streamflow averaged over 3 consecutive days (m3 s-1 / mm)

For variable pcp the following columns are also included: #'

nrainy number of rainy days

total total rain (mm)

meanrainy mean precipitation of rainy days (mm / day)

sdrainy standard deviation of precipitation of rainy days (mm / day)

Computes a set of streamflow statistics at the monthly scale.

References NA

Example 1 (not run) # monthly <- piragua_monthly(dat)

piragua_plot *Produces a plot with time series of all the statistics, for a given station.*

Description

Produces a plot with time series of all the statistics, for a given station.

Usage

```
piragua_plot(da, mo, an, tr, co, st, fo = NA, variable = "q", save = TRUE)
```

Arguments

da	A univariate xts object with the daily streamflow on a given station.
mo	A data frame with monthly streamflow statistics for the same station, typically from a call to piragua_monthly().
an	A data frame with annual streamflow statistics for the same station, typically from a call to piragua_annual().
st	The number of the station.
fo	Character: a suffix used to construct the names of resulting, files e.g. '1951-2015'. Defaults to NA, so no suffix is used.
save	Logical: whether or not to write the results to disk. If FALSE it will not save to disk, but a plot will be returned. Defaults to TRUE.
metadat	Character: one of (streamflow, climate), determining which metadata file to use. This shall depend on the type of variable being analysed (i.e., streamflow or a climatic one).

Value

```
A `ggplot` object. It also stores the plot in a file,
        if `save` is set to TRUE.
```

References

NA

Examples

```
# Example 1 (not run)
```

`piragua_trend` *Compute a linear trend following the Yue-Pilon method of prewhitening and Sen's slope, and use a Kendall test for significance. Using function* `zyp.yuepilon()` *from package* `zyp.t`.

Usage

```
piragua_trend(x, variable = "q")
```

Arguments

`x`	A univariate `xts` object with the daily streamflow on a given station.

Value

`A data frame object with the following columns:`

lbound the lower bound of the trend's confidence interval.

trend change per year (i.e. the Sen's slope).

trendd change per decade.

trendp change over the whole period.

trend_r change per year, expressed in %.

trendd_r change per decade, expressed in %.

trendp_r change over the whole period, expressed in %.

ubound upper bound of the trend's confidence interval.

tau Kendall's tau statistic computed on the final detrended timeseries.

sig Kendall's P-value computed for the final detrended timeseries.

nruns number of runs required to converge upon a trend.

autocor autocorrelation of the final detrended timeseries.

valid_frac fraction of the data which is valid (not NA) once autocorrelation is removed.

linear least squares fitted trend on the same data.

intercept intercept of the Sen's slope (trend).

These statistics are computed for each of the variables resulting from calls to `piragua_monthly()` and `piragua_annual()`.

Example 1 (not run) # piragua_trend(annual)

Example 2 (not run) # piragua_trend(monthly)

Yue, S., P. Pilon, B. Phinney and G. Cavadias. The influence of autocorrelation on the ability to detect trend in hydrological series. *Hydrological Processes* 16: 1807-1829 (2002).

David Bronaugh and Arelia Werner for the Pacific Climate Impacts Consortium. zyp: Zhang + Yue-Pilon Trends Package. R package version 0.10-1.1 (2019). https://CRAN.R-project.org/package=zyp.

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