

Package ‘scPDSI’

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Type Package

Title Calculation of the Conventional and Self-Calibrating Palmer Drought Severity Index

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Description Calculating the monthly conventional and self-calibrating Palmer Drought Severity Index (PDSI and scPDSI) using the precipitation and potential evapotranspiration data. The function to calculate PDSI is based on the C++ source codes developed by Nathan Wells, Steve Goddard and Michael J. Hayes, University of Nebraska-Lincoln.
Reference: Palmer W. (1965). Meteorological drought. U.s.department of Commerce Weather Bureau Research Paper, <<https://www.ncdc.noaa.gov/temp-and-precip/drought/docs/palmer.pdf>>; Wells N., Goddard S., Hayes M. J. (2004). A Self-Calibrating Palmer Drought Severity Index. Journal of Climate, 17(12):2335-2351, <DOI:10.1175/1520-0442(2004)017%3C2335:ASPDSI%3E2.0.CO;2>.

License GPL-3

Encoding UTF-8

LazyData true

Depends R (>= 2.10)

Imports stats, Rcpp (>= 0.12.0)

URL <https://github.com/Sibada/scPDSI>

BugReports <https://github.com/Sibada/scPDSI/issues>

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Datasets	<i>Datasets for illustrating the functions in the scPDSI package.</i>
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Description

This is the sample dataset used in the examples of the scPDSI package. It includes monthly precipitation (P, in mm) and potential evapotranspiration (PE) for the Lubuge Bouyei and Miao Minority Autonomous County (104.5 degree E, 24.75 degree N) from 1960 to 2016 (total 57 years). Lubuge is also the centroid of the severe drought disaster of 2009-2010 in the southwest China.

Usage

```
data(Lubuge)
```

Format

Lubuge dataset:

P monthly precipitation totals [mm].

PE monthly potential evapotranspiration totals [mm].

Details

See description.

Author(s)

Data were ported to R by Ruida Zhong.

Source

Data of Lubuge were obtained from the CRU TS v4.01 datasets released by the Climatic Research Unit (CRU) (https://crudata.uea.ac.uk/cru/data/hrg/cru_ts_4.01/).

Examples

```
data(Lubuge)
```

pdsi *Calculate the (sc)PDSI*

Description

Calculating the monthly conventional Palmer Drought Severity Index (PDSI) and Self-calibrating PDSI (scPDSI) using the precipitation and potential evapotranspiration.

Usage

```
pdsi(P, PE, AWC = 100, start = NULL, end = NULL, cal_start = NULL,
     cal_end = NULL, sc = TRUE)
```

Arguments

P	Monthly precipitation series without NA [mm]. Can be a time series.
PE	Monthly potential evapotranspiration corresponding to the precipitation series. Can be calculated by the Penman-Monteith or the Thonthwate equation [mm].
AWC	Available soil water capacity of the soil layer [mm]. Default 100 mm.
start	Integer. Start year of the PDSI to be calculate default 1.
end	Integer. End year of the PDSI to be calculate.
cal_start	Integer. Start year of the calibrate period. Default is start year.
cal_end	Integer. End year of the calibrate period. Default is end year.
sc	Bool. Should use the self-calibrating procedure to calculate the climatological coefficient (K2 and duration coefficients). If not it would use the default parameters of Palmer (1965).

Details

The Palmer Drought Severity Index (PDSI), proposed by Palmer (1965), is a widely used drought indicator to quantify the long-term drought conditions, for an area at a certain time. The PDSI is a semi-physical based drought index calculated using the precipitation and potential evapotranspiration data, based on a simple two-layer bucket water balance model. Conventionally, the constants to calculate the PDSI were firstly empirically derived by using the meteorological records in Kansas and Iowa in middle US with a semi-arid climate conditions, therefore the conventional PDSI usually could not satisfactorily represent the drought conditions for other areas around the world, which also makes spatial comparisons of PDSI values difficult.

For this, Wells et al. (2004) proposed a self-calibrating Palmer Drought Severity Index (scPDSI). The scPDSI could automatically adjust the empirical constants in the PDSI computation with dynamically calculated values. Several works have proved that the scPDSI performs better in spatially comparison than the conventional PDSI. For more details please see the works of Wells et al. (2004).

This function could also calculate the conventional PDSI with revised constants. Before the scPDSI appeared, the PDSI calculation has also been revised focusing on the local climate characteristics in many area around the world. Those constants could be reset by using the global options before calculating the PDSI e.g.:

```
options(PDSI.coe.K1.1 = 1.6)
```

And calculation in the PDSI would be:

$$Ki0 = coeK11 * lg(((PEi + Ri + ROi)/(Pi + Li) + coeK12)/Di) + coeK13$$

$$Ki = coeK2 / (\sum Dj * Kj) * Ki$$

$$X[i] = p * X[i - 1] + q * Z[i]$$

coeK11, *coeK12*, *coeK13*, *coeK2*, *p*, and *q* are corresponding to `PDSI.coe.K1.1`, `PDSI.coe.K1.2`, `PDSI.coe.K1.3`, `PDSI.coe.K2`, `PDSI.p`, and `PDSI.q`, respectively.

For example, in a national standard in China about meteorological drought level (GB/T 20481-2017), the PDSI was revised by re-adjust the constants in the calculation. To use the PDSI based on this standard should set the global options of R as follows:

```
options(PDSI.coe.K1.1 = 1.6)
options(PDSI.coe.K1.3 = 0.4)
options(PDSI.coe.K2 = 16.84)
options(PDSI.p = 0.755)
options(PDSI.q = 1/1.63)
```

Value

This function return an object of class `pdsi`.

The object of class `pdsi` is a list containing the following components:

- `call`: the call to `pdsi` used to generate the object.
- `X`: time series of the X values, i.e. the Palmer Drought Severity Index (PDSI).
- `PHDI`: time series of the Palmer hydrological drought index (PHDI).
- `WPLM`: time series of the weighted PDSI (WPLM).
- `inter.vars`: An time series matrix containing the intermediate variables, including P (input precipitation), PE (input potential evapotranspiration), PR (potential recharge of soil moisture), PRO (potential runoff), PL (potential loss of soil moisture), d (water deficiencies), Z (water anomaly index, i.e. Z index), Prob (probability to end the wet or dry spell), X1, X2 and X3 (intermediate variables of calculating the X values).
- `clim.coes`: a matrix of the climate coefficients including alpha, beta, gamma, delta, and K1 coefficient for each month in a year.
- `calib.coes`: a matrix of the coefficients in the self-calibrating procedure of scPDSI, including m, b (slope and intercept of the duration-accumulated Z index plot), p, q (duration factors), and K2 (ratio to adjust K coefficient) for wet and dry spell, respectively. Note that the P and PE would be converted from mm to inch in the calculation, therefore the units of m, b would also be inch correspondingly.

References

Palmer W., 1965. Meteorological drought. U.s.department of Commerce Weather Bureau Research Paper.

Wells, N., Goddard, S., Hayes, M. J., 2004. A Self-Calibrating Palmer Drought Severity Index. Journal of Climate, 17(12):2335-2351.

Examples

```
library(scPDSI)
data(Lubuge)

P <- Lubuge$P
PE <- Lubuge$PE
sc_pdsi <- pdsi(P, PE, start = 1960)

plot(sc_pdsi) # plot PDSI
plot(sc_pdsi, index = "PHDI") # plot PHDI
plot(sc_pdsi, index = "WPLM") # plot weighted PDSI

# Without self-calibrating.
ori_pdsi <- pdsi(P, PE, start = 1960, sc = FALSE)
plot(ori_pdsi)

# Without self-calibrating and use standards of
# mainland China. (GB/T 20481-2017)
options(PDSI.coe.K1.1 = 1.6)
options(PDSI.coe.K1.3 = 0.4)
options(PDSI.coe.K2 = 16.84)
options(PDSI.p = 0.755)
options(PDSI.q = 1/1.63)
gb_pdsi <- pdsi(P, PE, start = 1960, sc = FALSE)
plot(gb_pdsi)
```

plot.pdsi

plot(sc)PDSI

Description

plot the timeseries of calculated (sc)PDSI.

Usage

```
## S3 method for class 'pdsi'
plot(x, tit = NULL, index = "PDSI", ...)
```

Arguments

<code>x</code>	an object of class <code>pdsi</code> .
<code>tit</code>	title of the plot.
<code>index</code>	determines PDSI, PHDI (Palmer hydrological drought index) or WPLM (weighted PDSI) to be plotted. Default "PDSI".
<code>...</code>	additional parameters, not used at present.

Details

Plot the timeseries of (sc)PDSI using function `pdsi`. Values over 6 or below -6 and NA values would be shown by grey points.

See Also

[pdsi](#)

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