Standardized Precipitation Evapotranspiration Index (SPEI) Dataset in Yunnan Province, China

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Abstract: Yunnan province is located in southwest of China. Its geographical location ranges between 21°8′32″N–29°15′8″N and 97°31′39″–106°11′47″E. It borders Sichuan, Guizhou, Guangxi and Tibet, and is adjacent to Burma, Laos and Vietnam. In recent years, regional drought research has become more urgently required as drought event frequency in Yunnan province has increased. Based on the meteorological data from 33 meteorological stations in Yunnan province from 1998 to 2012 and the Standardized Precipitation Evapotranspiration Index (SPEI) model, the Standardized Precipitation Evapotranspiration Index (SPEI) Dataset in Yunnan province, China was developed. The data results indicate the intensity of drought in the region has been gradually increasing. The dataset includes: (1) the location information for the 33 data sites, and (2) SPEI values for each of the 33 data sites from 1998–2012. The dataset is consisted of 9 data files and is archived in .kmz, .shp and .xlsx data formats with the data size of 677 KB (212 KB in compression).

Keywords: Yunnan; Southwest China; SPEI; drought

1 Introduction

In the context of global climate change, the frequent occurrence of extreme weather has further exacerbated global droughts[1]. Characterizing droughts requires evaluating the combined effects of precipitation and temperature changes, which can be difficult using a traditional single drought index[2]. Vicente-Serrano *et al*.[3] proposed a new climate drought index, the Standardized Precipitation Evapotranspiration Index (SPEI), based on the Standardized Precipitation Index (SPI). The index is based on temperature and precipitation data and the integrated sensitivity of the Palmer Drought Index (Palmer Drought Severity Index, PDSI) to changes in evaporative demand. Therefore, it is a simple, spatio-temporal attribute of SPI, and an ideal tool for monitoring and analyzing drought processes[2–3].

This study calculated the SPEI from meteorological stations in Yunnan province at 3, 6, 12 and 24 month intervals from 1998 to 2012 years to analyze the occurrence of drought in Yunnan province, China[5].

2 Metadata of Dataset

The metadata for the dataset of standardized precipitation evapotranspiration index in Yunnan province[6] is summarized in Table 1. It includes the full name, short name, authors, year of the dataset, temporal resolution, spatial resolution, data format, data size, data files, data publisher and data sharing policy for the dataset.

Table 1   Metadata summary of standardized precipitation evapotranspiration index dataset in Yunnan province, China

Items	Description
Dataset full name	Standardized precipitation evapotranspiration index (SPEI) dataset of Yunnan province (1998–2012)
Dataset short name	YunnanSPEI_1998-2012
Authors	Liu, S. L. C-1377-2017, shiliangliu@bnu.edu.cn School of Environment, Cheng, F.Y. S-6509-2016, chengfangyan@mail.bnu.edu.cn Beijing Normal University Zhang, Y.Q. P-3944-2017, 13324103182@163.com Hou, X. Y. S-6962-2016, houxiaoyun526@126.com Wu, X. V-5240-2017, 849934301@qq.com
Geographical region	Yunnan province is located in the mainland of Asia. It is located in the Southeast Asian Peninsula between the Pacific Ocean and India ocean. The geographic range includes 21°8′32″–29°15′8″N, 97°31′39″–106°11′47″E. Yunnan province is bordering on 4 provinces of Sichuan, Guizhou, Guangxi and Tibet, and adjacent to 3 countries of Burma, Laos and Vietnam
Year	1998–2012
Data format	.kmz, .shp, .xlsx
Data size	677 KB (212 KB in compressed)
Data files	The dataset consists of two group files: (1) geolocations of 33 data sites; (2) the SPEI data of each data sites
Foundation(s)	Ministry of Science and Technology of P. R. China (2016YFC0502103); National Natural Science Foundation of China (41571173)
Data publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	*Data* from the Global Change Research Data Publishing & Repository includes metadata, datasets (data products), and publications (in this case, in the *Journal of Global Change Data & Discovery*). *Data* sharing policy includes: (1) *Data* are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use *Data* subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute *Data* subject to written permission from the GCdataPR Editorial Office and the issuance of a *Data* redistribution license; and (4) If *Data* are used to compile new datasets, the 'ten per cent principal' should be followed such that *Data* records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[7]

3 Methods

3.1 Sources of Data

The meteorological data used in the research are monthly precipitation and temperature data from 33 meteorological stations in Yunnan province from 1998 to 2012. The monthly precipitation and average temperature data are provided by the national meteorological data sharing service platform from the meteorological center of the China Meteorological Administration (http://data.cma.cn/).
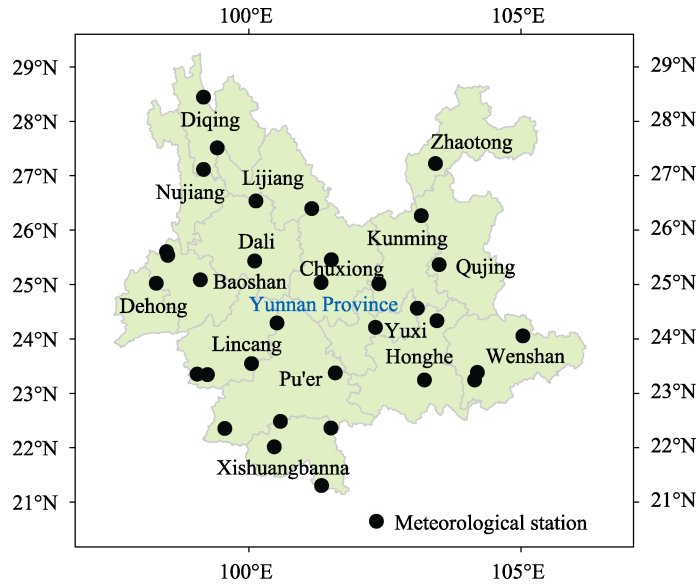
Figure 1   Location map of the 33 data sites in Yunnan province, China

3.2 Model

The dataset was developed by the SPEI model using potential evapotranspiration based on SPI, as described by Vicente-Serrano [3].

The detailed steps in the SPEI calculation are as follows [5]:

1) Calculate the potential evapotranspiration using the Thornthwaite method.
2) Calculate the difference between monthly precipitation and evapotranspiration.

$$D_i = P_i - PET_i \tag{1}$$

where D_i is the difference between precipitation and evapotranspiration, P_i is monthly precipitation and PET_i is monthly evapotranspiration.

3) Normalize the Di data sequence. Because of potential negative values in the original data sequence $Di,$ the SPEI index uses the log-logistic probability distribution of three parameters. The cumulative function of the log-logistic probability distribution of a given time scale is as follows:

$$F(x) = \left[1 + \left(\frac{\alpha}{x - y} \right)^{\beta} \right]^{-1} \tag{2}$$

where α is the scale parameter and β is the form parameter, which are obtained from fitting using the linear moment method.

Then, the cumulative probability density is standardized:

$$P = 1 - F(x) \tag{3}$$

When the cumulative probability $P \leqslant 0.5,$

$$W = -2\ln(P) \tag{4}$$

$$SPEI = W - \frac{C_0 + C_1 W + C_2 W^2}{1 + d_1 W + d_2 W^2 + d_3 W^3} \tag{5}$$

where W is the cumulative probability function value of the derived function for evapotranspiration, $C_0 = 2.515,517$，$C_1 = 0.010,328$，$d_1 = 1.432,788$，$d_2 = 0.189,269$，$d_3 = 0.001,308.$ When $P > 0.5$, the SPEI transform symbols are represented by 1−P.
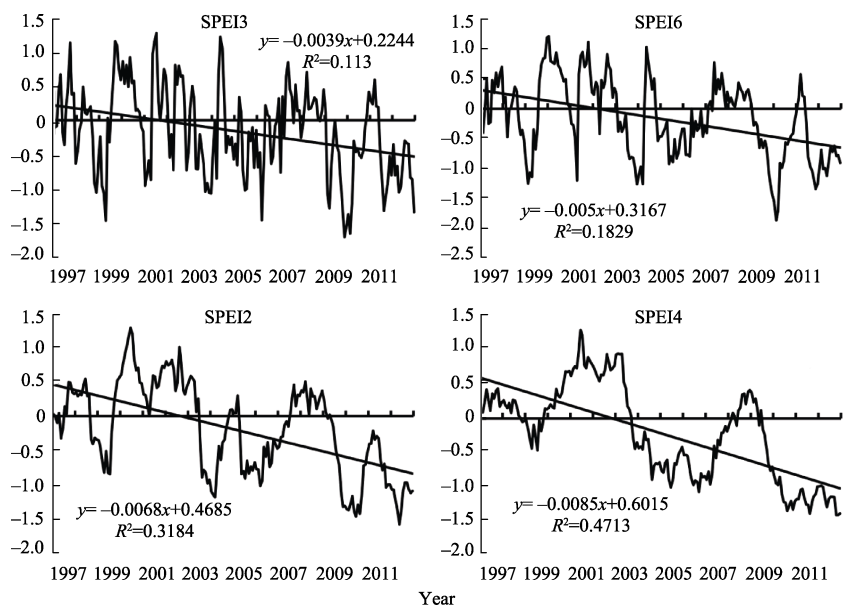
4 Results

4.1 Dataset Structure

The dataset containing the SPEI values from Yunnan province (1998−2012) can be acquired by downloading the .rar file compression package. The dataset consists of two data files, the point bit and SPEI data from each meteorological station. The weather station location data (Station.shp) is stored in Shape file format. The attribute table contains the location numbers of each meteorological station; the part of the dataset is shown in Table 2. The SPEI data (YunnanSPEI98-12.xls) from the meteorological stations are stored in XML format. Attribute information includes the station number, date, SPEI-3, SPEI-6, SPEI-12 and SPEI-24 for each site.

Table 2   Structure of the SPEI data file (1998−2012) (Part)

Code	Year	Month	SPEI-3	SPEI-6	SPEI-12	SPEI-24
56444	1998	1	0.910,218	1.405,472	0.755,184	0.651,674
56444	1998	2	0.354,802	1.226,318	0.736,720	0.389,720
56444	1998	3	1.628,373	0.793,755	1.096,529	0.639,470
56444	1998	4	0.516,306	0.720,538	1.325,416	0.650,676
56444	1998	5	0.427,654	0.454,335	1.422,186	0.260,293
56444	1998	6	−0.680,155	0.238,960	1.562,003	0.499,223
56444	1998	7	−0.554,716	−0.235,120	0.758,294	0.456,951
56444	1998	8	−0.072,008	0.039,212	0.696,490	0.181,056
56444	1998	9	−0.111,926	−0.530,831	−0.208,498	0.320,678
56444	1998	10	0.587,437	−0.123,503	0.202,388	0.353,049
56444	1998	11	0.687,330	0.183,279	0.260,906	0.585,221
56444	1998	12	0.585,163	0.083,873	0.109,124	0.580,234

Figure 2   The long-term dynamic characteristics of the SPEI[5] in Yunnan province, China

4.2 Results

Different SPEI values show similar decreasing tendencies; that is, the drought trends increased gradually. However, at different time scales, the sensibility of SPEI values varied slightly (Fig. 2). At shorter time scales, the slope of the trend line is generally lower. In addition, there are many differences in drought characteristics, based on SPEI, across time scales. The large fluctuations in SPEI3 indicate that it is more sensitive to short-term precipitation, while SPEI6 is more affected by wet and dry periods, with larger fluctuations. Trends in SPEI12 and SPEI24 are gentler, and they more accurately reflect the drought the annual and multiannual periods.

5 Discussion

In this study, regional drought characteristics indicated from the SPEI are in agreement with the temporal trends described by Niu Kaijie[8] and others. Although the Thornthwaite method for calculating potential evapotranspiration does not take into account the effects of radiation, the latitude of the study area is small and difference in radiation is relatively low. Therefore, the radiation difference is ignored when we explore changes in SPEI.

Author Contributions

Liu, S. L. designed the algorithms of dataset. Cheng, F. Y., Hou, X. Y., Yin, Y. J., Zhang, Y.Q., and Wu, X. contributed to the data processing and analysis. Liu, S. L. wrote the data paper.

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