Spatio-temporal trend analysis of precipitation in Guizhou province based on GIS technology

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Abstract. Precipitation changes are closely related to human production and life. Based on the data of Guizhou Province from 1998 to 2012, the temporal and spatial characteristics of precipitation in Guizhou Province were analyzed from the annual, seasonal and monthly scales by linear trend analysis and ArcGIS kriging spatial interpolation. The results show that the annual precipitation is mainly concentrated in the summer, accounting for 47.6% of the year, followed by spring accounted for 26.9%, autumn accounted for 18.6% in winter accounted for 6.9%. In the time, the precipitation in the study area shows a decreasing trend in the annual scale, seasonal scale and July. The overall spatial precipitation distribution shows a decreasing trend from the east to the west. The precipitation also in the south is higher than the northern region.

1. Introduction

Precipitation changes are closely related to human production and life. In the case of global warming, the precipitation in each region changes to varying degrees. one of the factors is subjected to climate change, is precipitation. Precipitation is characterized by randomness, uncertainty, complexity and uneven distribution. Therefore, it is of great significance to study the temporal and spatial characteristics of precipitation.

Domestic and foreign scholars have carried out a large number of related research in different parts of the world. The results show the different behaviour of governing conditions. In this regards, Kanae et al. studied the precipitation change in Tokyo area. They obtained the characteristics and genesis of precipitation in different periods [1]. Additionally, Goswami et al. used precipitation data from central India to show a significant increase in extreme precipitation events[2]. I would like to note the summary of the research results for your literature review, here. Sen et al. analyzed the extreme precipitation trend of the Indian subcontinent in 1980-2000, and concluded that the extreme precipitation events on the hour scale also showed different trends[3]. Lu Zhihua et al.studied the temporal and spatial characteristics of precipitation in the Songhua River Basin. The results showed that the annual precipitation in the Songhua River Basin had a decreasing trend[4]. Lu Hongya et al. studied the spatio-temporal variation of extreme precipitation events in the Everest area and found that the extreme precipitation index in the region gradually increased from east to west[5]. Yang Xiaojing

et al. characteristics of extreme precipitation in the Yunnan Province and the spatial distribution characteristics of the study shows that the number of light rain and continuous precipitation in Yunnan Province are reduced, the extreme precipitation increased significantly[6]. Wu Jianfeng et al. used TRMM(Tropical Rainfall Measuring Mission) satellite precipitation data to analyse the spatial and temporal characteristics of precipitation in Guizhou Province[7]. Deng Han - qing et al. analysis of temporal and spatial characteristics of annual precipitation in the Pearl River Basin[8]. Chen et al. used the precipitation data of the Qilian Mountains and the data of the spruce width of the spruce trees to study the temporal and spatial variation of precipitation in the area[9].
Therefore, the paper takes the Guizhou Province as the research object, and uses the linear trend analysis and Kriging spatial interpolation to study the temporal and spatial characteristics of precipitation in the Guizhou Province. To provide important reference value for the agricultural production and the study of precipitation change in other regions of the Guizhou Province.

2. Study area

The Guizhou Province is located in the southeast of the Qinghai-Tibet Plateau, located in China's first ladder and the second step of the buffer zone. The latitude and longitude range is between 103°36' - 109°35' E and 24° 37' -29°13' N. The terrain of Guizhou Province is mainly mountainous and hilly, and the west is higher than that of the east. The Guizhou Province belongs to the subtropical monsoon climate zone with an annual average temperature of around 15°C. The annual average precipitation is about 1300mm, and the precipitation season is unevenly distributed. The Guizhou River is located in the Yangtze River and the Pearl River Basin upstream staggered zone. The Guizhou has a large network density and the province's rivers originated in the middle and west, north, east and south are fan-like radial.

3. Data and methods

3.1. Data sources and processing

In this paper, the monthly precipitation data of 26 meteorological stations in Guizhou Province from 1998 to 2012 are used as data sources.. The data were from China Meteorological Data Sharing Service Center (http://www.cma.gov.cn). This paper is divided into four seasons by climate statistics: spring (March - May), summer (June - August), autumn (September - November), winter (December - February).

3.2. Methods

3.2.1. Linear trend method Linear *trend* analysis refers to the use of *n* sample size, the time is expressed by t_i, the precipitation variable is denoted by x_i to establish a linear regression equation between x_i and t_i:

$$\hat{x}_i = a + bt_i \tag{1}$$

In the above formula, i=1, 2, ... n, $\hat{x}$ is used as the precipitation element, a is the regression constant, b is the regression coefficient, and t is the time.

3.2.2. Kriging method In this paper, the general kriging method is used to obtain the spatial distribution characteristics of precipitation in the Guizhou Province. Ordinary Kriging method is to consider the spatial correlation factors, estimate a general point of a measurement equation.

$$Z_0 = \sum_{x=1}^{s} Z_x W_x \tag{2}$$

Where Z_0 is the estimated value, Z_x is the known value of point x, W_x is the weight of x, and s is the number of points used to estimate the sample[10].

4. Spatio-temporal variation of precipitation in Guizhou province

4.1. Temporal variation of precipitation

4.1.1. Temporal distribution of annual precipitation

The spring precipitation in Guizhou Province accounts for 26.9% of the annual precipitation, 47.6% in summer, 18.6% in summer and 6.9% in winter. The precipitation is mainly concentrated in the summer. The possible reason is that Guizhou Province belongs to the subtropical monsoon climate, with high temperature and high precipitation in summer. Precipitation is less in winter The average annual precipitation in 1998 - 2012 is 1117.30 mm. The maximum annual precipitation is 1266.81 mm, which occurred in 2008, due to snowfall in most areas in 2008; the minimum precipitation is 883.1 mm, which occurred in 2011.

4.1.2. Temporal distribution of seasonal precipitation

In spring, the precipitation shows a downward trend as a whole. Guizhou Province in 1998 - 2012 spring precipitation between 193.92-393.88 mm, the average annual precipitation in spring for the 301.11 mm. The maximum and minimum precipitation in spring was 393.88 and 193.91 mm, which occurred in 2002 and 2011, respectively. In summer, the precipitation in Guizhou Province has been declining for the past 15 years, and the precipitation is in the range of 357.40 -675.8 mm. The average precipitation in summer is 531.81 mm and the maximum precipitation is in 1999. the minimum precipitation in 2011, 357.40mm. Autumn precipitation varied greatly over time, showing an overall upward trend. Precipitation in the 124.95mm-307.66mm between the average rainfall in autumn is 207.86mm. Winter precipitation, in 1998 - 2004 changes in the larger range, in 2004 - 2012 changes in the range of small. The overall performance of the downward trend.

4.1.3. Temporal distribution of monthly precipitation

Precipitation in Guizhou Province is mainly concentrated in the summer, this paper selected a representative July precipitation analysis. July precipitation for many years between 61.48mm-277.90 mm, the average rainfall is 180.26mm. The maximum precipitation is in 2007, the precipitation is 277.90 mm; the minimum precipitation is in 2011, 61.48mm. Precipitation in July for the overall trend was declining.

4.2. Spatial variation of precipitation

4.2.1. Spatial variation of annual precipitation

The annual precipitation is decreasing from east to west, and the distribution is in the form. The average annual precipitation is between 806.48mm and 1348.25mm. The annual precipitation area is located in Tongren, San Sui, Jinping, Liping, Libo and the poor area is located in Weining, Hezhang. The spatial distribution of annual precipitation is not uniform. The possible reason is that the terrain of Guizhou Province is relatively low in the west and east, with the farther away from the eastern ocean, the smaller the influence of the warm and humid air. Therefore, the eastern part of the precipitation is relatively rich, while the western Wei Ning, He Zhang from the ocean far, high altitude, less precipitation[11].

4.2.2. Spatial variation of seasonal precipitation

As can be seen from Figure 1, the spatial distribution characteristics of precipitation in the spring of Guizhou Province are decreasing from east to west and distributed in strip shape. Spring annual average precipitation in 133.4mm-455.0mm. Spring precipitation rich area is located in the eastern part of Tongren, San Sui, Jin Ping, Liping, poor area is located in western Guizhou Weining, Hezhang. The distribution of precipitation in summer is characterized by decreasing the northward, east and south directions of the central and western parts. The precipitation in the southwest is greater than that in the northeast, and the precipitation in the east is greater than that in the west. The precipitation in the middle and north is annularly distributed, and the precipitation in the south is banded. The spatial

distribution of autumn precipitation is characterized by relatively abundant precipitation in the northeast, moderate precipitation in the middle, and less precipitation in the western, southeastern and southern parts. Winter precipitation gradually decreases from the eastern part of Guizhou to the west. The average annual precipitation is between 29.69 mm and 163.24 mm. Winter precipitation rich area is located in the southeast of Liping, Jinping, poor areas located in Weining, Hezhang, Qixing off, Zhongshan.

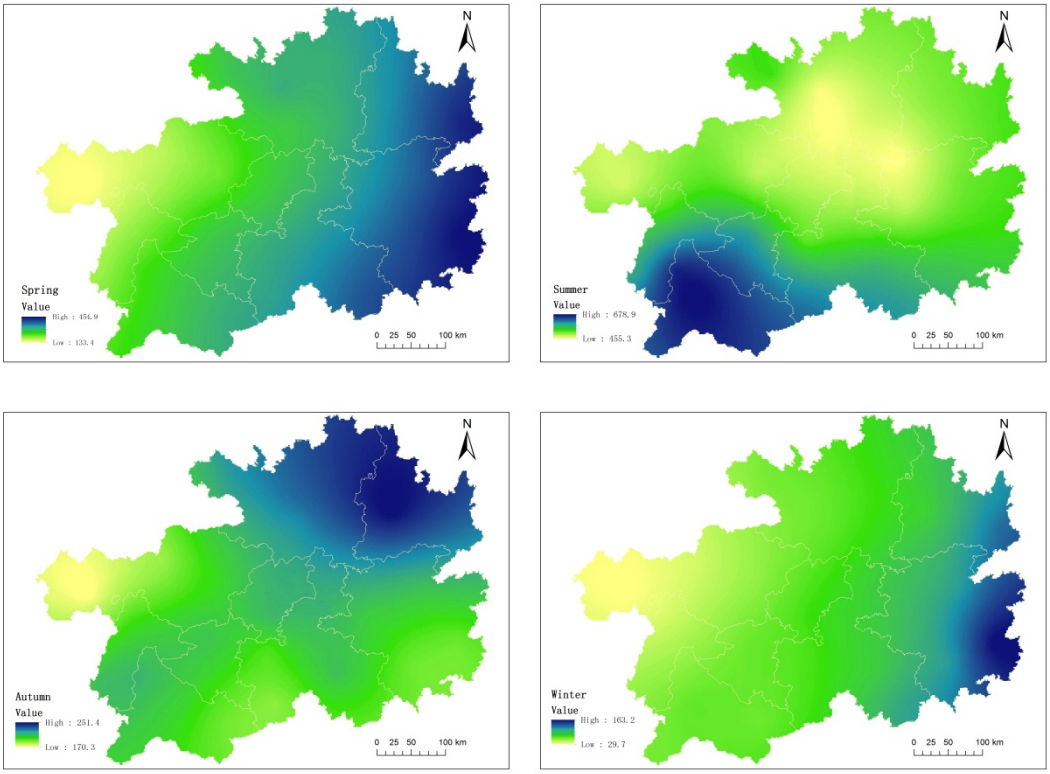

Figure 1. Spatial distribution characteristics of precipitation in four seasons of study area

4.2.3. Monthly precipitation spatial variation

In July, the spatial distribution of precipitation in Guizhou Province gradually decreased from southwest to northeast, but the precipitation in Tongzi and Sansei decreased rapidly. The reason is that the rain belt is moved northward and blocked by the eastern bay. July annual average precipitation in 142.17mm-226.44mm between. The most abundant areas of precipitation are Pu'an, Xingren, Wangmo, Luodian, and the area with small precipitation is Tongzi and Sansei.

5. Conclusion and discussion

5.1. main conclusion

Based on the monthly precipitation data of 26 meteorological stations in Guizhou Province, the temporal and spatial characteristics of precipitation were analyzed from the three scales of the year, season and month by linear trend analysis and Kriging interpolation. The following conclusions are drawn:

The temporal classification analyses (i.e., year, spring, summer, winter, month) indicated a slightly downward trend in precipitation in general, although autumn precipitation is on the rise. Spring precipitation accounted for 26.95% of annual precipitation, summer accounted for 47.60%, autumn accounted for 18.60%, winter accounted for 6.85%, precipitation is mainly concentrated in the summer.

The spatial analyses indicated, the eastern part of the precipitation than the west, the southern part of the precipitation than the north side, but the precipitation in the northeast than the southern part of the precipitation. Precipitation rich areas located in the Pu'an, Xingren, Wang Mo, Jin Ping, Liping,

precipitation concentrated areas concentrated in Weining, Hezhang, Tongzi, Yuqing, San Sui, Honghuagang, Qianxi, Meitan. Therefore, the precipitation-rich areas very likely need to pay attention to flood prevention, where as precipitation-starved areas very likely need to pay attention to drought prevention.

5.2. Research prospects

Based on the monthly precipitation data of Guizhou Province, this paper uses linear trend analysis method and spatial interpolation to study the temporal and spatial characteristics of precipitation, which is of great reference value for the production and living of the study area and the prevention of drought and flood disaster. However, there are some shortcomings in this study. First, the collected precipitation data are few and can not analyze the time-varying period of precipitation from the time scale. Secondly, the research method adopted in this paper is relatively small and the conclusion is not enough Third, this paper only studies the temporal and spatial distribution of precipitation characteristics. The lack of agricultural weather observation data, limits the application of our findings. We plan future research and continuous improvement to the infrastructure.

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