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Research on Rainfall Characteristics in Zhengzhou Based on Pearson Correlation Analysis and Moving Average Method

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Abstract: *The occurrence of flood disasters is related to persistent heavy rainfall anomalies. Under the influence of climate anomalies, the rainfall, rainfall intensity and frequency in Zhengzhou have been rising in recent decades. In order to further describe the rainfall characteristics in Zhengzhou area, Pearson correlation analysis and moving average method are used to analyze the characteristics of precipitation in Zhengzhou from 1973 to 2020 from the Total amount, intensity and duration of precision. The results show that during this period, the average annual precision in Zhengzhou was 660 mm, and the top three years were 2003, 2016 and 1983. The annual average precipitation intensity in Zhengzhou is 3.12 mm/d, And the linear tendentiousness trends of heavy rain and torrential rain are -0.0008 d/a and -0.005 d/a respectfully. The above research in this paper can provide reference for the urban response plan and long-term construction planning under extreme precipitation conditions.*

Keywords: *Pearson Correlation Analysis, Moving Average Method, Extreme Precipitation, Precipitation in Zhengzhou*

1. Introduction

Flood disaster is the most prominent natural disaster in China's cities at present[1]. Affected by climate change[2], rapid urbanization[3] and backward infrastructure construction[4], China city is facing serious flood disaster. In view of the frequent flood disasters in China, a large number of scholars have studied their frequency, distribution pattern and disaster losses from time and space dimensions respectively. Liu Jiafu et al.[5] pointed out that from 2004 to 2018, the flood disaster losses in the three northeastern provinces showed a fluctuating trend of first rising and then falling, and the affected area and disaster rate in Heilongjiang Province were the highest in space; Huang Yafei et al.[6] pointed out that from 1978 to 2018, the frequency and intensity of rainstorm in the south of the Yangtze River fluctuated and increased, and it was characterized by concentrated rainfall in the central and eastern parts and weak rainfall in the west. Chen Chuanlei et al.[7] pointed out that the extremely long-lasting rainstorm in Liaoning Province is widely distributed and can be roughly divided into four prone areas, and July-August is the rainstorm-prone period; Yu Xuan et al.[8] pointed out that the rainstorm in China has generally increased since 1984-2008, and the spatial distribution is generally higher in the south than in the north and higher in the east than in the west.

The occurrence of flood disasters is related to persistent heavy rainfall anomalies[9]. Since July 17th, 2021, Henan Province has been continuously affected by extremely heavy precipitation, especially the torrential rain and flood disaster in Zhengzhou City, which directly led to the loss of 655 billion yuan in Zhengzhou[10].

The heavy rain caused a large number of urban infrastructures to be destroyed, and thousands of vehicles were turned into scrap iron, resulting in heavy economic losses. With the frequent occurrence of extreme weather events, how to scientifically and rationally deal with extreme weather events such as heavy precipitation, thunderstorm, gale, freezing rain and so on under the trend of climate change has become an increasingly concerned issue.

Based on this, this paper will take Zhengzhou area as an example, and analyze the annual variation characteristics of precipitation in Zhengzhou area by analyzing the daily precipitation observation data of three nearby weather stations in recent 70 years, and then quantitatively analyze the extreme precipitation events in Zhengzhou in 2021, so as to provide reference for urban response plans and

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long-term construction planning under extreme precipitation conditions.

2. Analysis of rainfall characteristics in Zhengzhou

2.1 Data preprocessing

The data includes the daily precipitation observation results of three weather stations near Zhengzhou in recent 70 years, which will be further processed in this paper.

2.1.1 Excluding the years with incomplete precipitation data

The observation data show that the precipitation in some years does not start from January, and it is incomplete and cannot be used as the basis for judging the precipitation in that year.

2.1.2 Eliminate the untrue and unreasonable daily precipitation data

The observed values under some indicators belong to abnormal observation data, which affects the subsequent analysis and therefore needs to be eliminated.

2.1.3 Eliminate discontinuous years

The precipitation data are not consecutive years, and the data from 1964 to 1974 are missing. In order to ensure the accuracy and readability of the analysis, the data from 1962 to 1964 are excluded, and the precipitation data from 1973 to 2020 for 48 years are analyzed.

After the above processing, Pearson correlation coefficient will be used to analyze the correlation between the year and the total precision, precipitation intensity and precipitation days in Zhengzhou. At the same time, the moving average method and moving T-test will be used to further analyze and display the chronological characteristics of precipitation characteristics in Zhengzhou from 1973 to 2020.

2.2 Analysis of specific characteristics

2.2.1 Characteristic analysis of total precipitation in Zhengzhou

As can be seen from Figure 1, the climate average of the total precipitation in Zhengzhou from 1973 to 2020 was 660 mm, with the maximum value of 827 mm in 2003 and the minimum value of 336 mm in 1999, which was consistent with the drought situation at that time. Except for 1999, the precipitation in Zhengzhou has basically remained above 450 mm for 48 years, with 24 years higher than the average and 24 years lower than the average. More precipitation and less precipitation alternate, and the precipitation level is relatively balanced. Among them, the top three years of precipitation are 2003, 2016 and 1983.

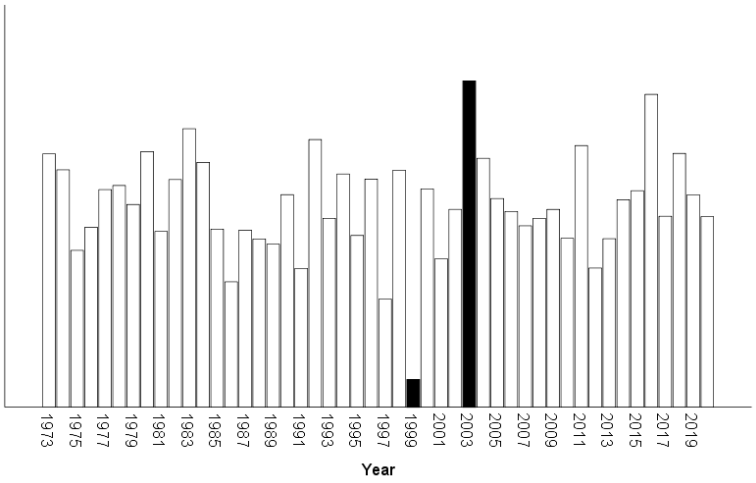

Figure 1: Total precipitation in Zhengzhou

It can be seen from Figure 2 that Zhengzhou is located in the north of China, with more precipitation in summer and autumn and less precipitation in spring and winter. Among them, summer precipitation accounts for 52% of the whole year, with the largest contribution value and the most

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prone to floods. In the past 48 years, the precipitation in Zhengzhou has shown an alternating trend, and the precipitation situation is relatively stable.

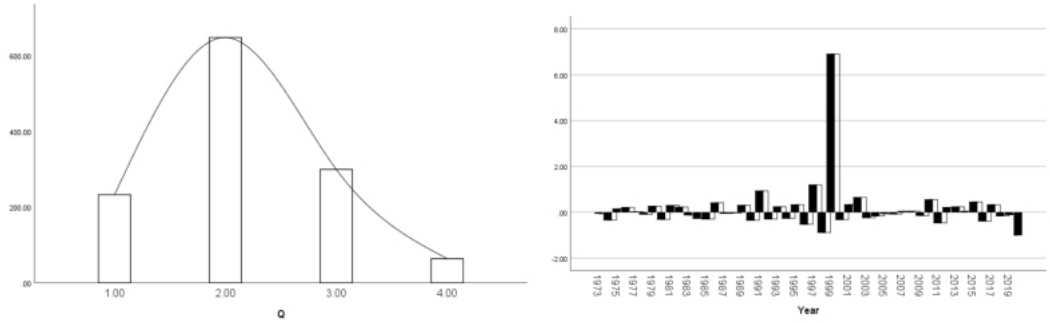

Figure 2: Seasonal characteristics (l) and annual variation (r) of average precipitation in Zhengzhou

2.2.2 Characteristic analysis of precipitation intensity in Zhengzhou

Figure 3 shows that the annual average precipitation intensity in Zhengzhou is 3.12 mm/d, with the maximum precipitation intensity of 4.67 mm/d in 1983 and the minimum precipitation intensity of 0.69 mm/d in 1999. Most of the precipitation intensity is 2.0-4.0 mm/d. From 1973 to 2020, the precipitation intensity in winter decreased significantly with a trend of 0.24 (mmd-1)/a (on the order of 0.05). In the interdecadal aspect, the precipitation intensity was on the high side in 1970s and 1980s, and began to decline from the mid-1980s to 2000, and continued to show a downward trend after 2000.

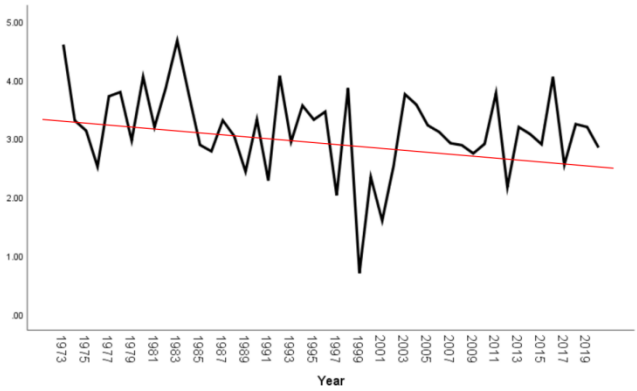

Figure 3: Average precipitation intensity in Zhengzhou from 1973 to 2020

2.2.3 Characteristic analysis of precipitation days in Zhengzhou

The long-term change of annual precipitation days in Zhengzhou in the past 48 years is shown in Figure 4. The average precipitation days for many years are 85 days, most of which are between 60 and 100 days, and those with more than 100 days and less than 60 days are 6 years and 2 years respectively. The year with the most precipitation days appeared in 2000 and at least in 1999. It can be seen from the figure that there is no obvious interannual change in the number of rainy days in Zhengzhou. Compared with the 20th century, the number of rainy days began to increase significantly after 2000.

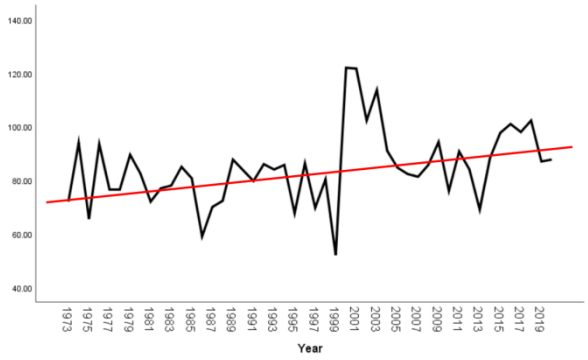

Figure 4: Precipitation days in Zhengzhou from 1973 to 2020

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See Figure 5 and Figure 6 for the change and trend of precipitation days of different grades. They show that the number of light rain days in Zhengzhou are nearly 78 days, with a linear trend of 0.34 d/a, showing a significant increasing trend (at 0.05 level); the number of moderate rain days are nearly 5 days, with a linear trend of 0.02 d/a, showing an insignificant increasing trend; the linear tendency trends of heavy rain and torrential rain are respectively 0.0008 d/a and 0.005 d/a, both showed no significant downward trend.

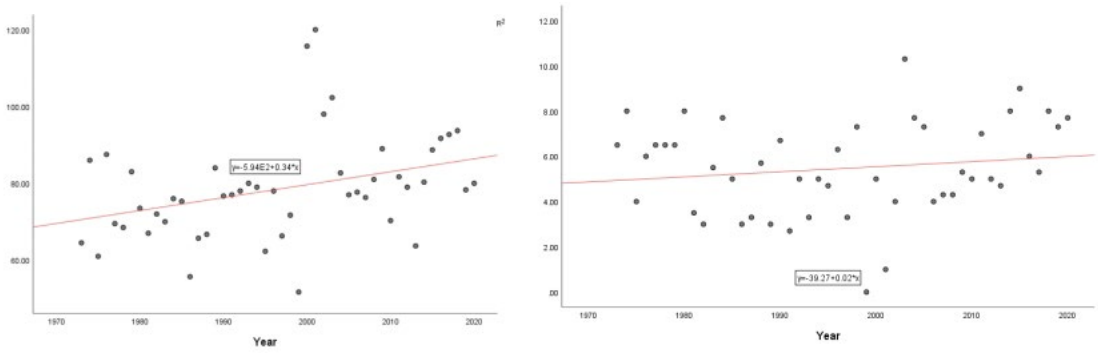

Figure 5: Light rain and moderate rain

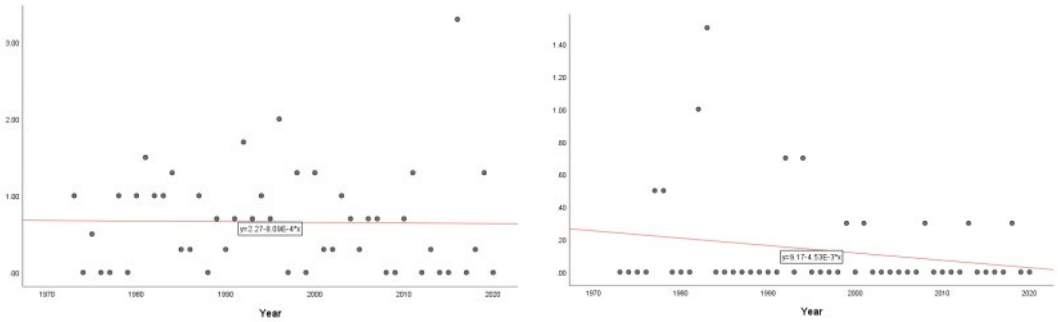

Figure 6: Heavy rain and torrential rain

2.2.4 Quantitative analysis of Zhengzhou flooding event

From July 18th to July 21st in 2021, there was a continuous heavy precipitation process in Zhengzhou, and the whole city experienced heavy rain and torrential rain. As of 12:00 on July 23rd, according to preliminary statistics, 395,989 people were resettled urgently, the affected area of crops was 44,209.73 hectares, and the direct economic loss was 655 billion yuan. Floods and secondary disasters caused by heavy rain had caused hundreds of deaths, as shown in Figure 7.

Figure 7: Average annual precipitation

The rainstorm in Zhengzhou lasted for 4 days, the strongest precipitation period occurred from 19th to 29th, and there was a heavy rainstorm in Zhengzhou for two consecutive days. From 2:00 on July 20th to 2:00 on July 21st, the total precipitation in Zhengzhou reached 622 mm within 24 hours, which is equivalent to the total precipitation in the previous year. Among them, the maximum hourly precipitation reached 201.9 mm.

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3. Conclusions

Under the background of global warming, extreme precipitation becomes more frequent, which seriously affects our life. Therefore, we need to raise our awareness of extreme weather.

In order to study the precipitation characteristics in Zhengzhou area, based on the daily precipitation observation data of three weather stations near Zhengzhou city in recent 70 years, data preprocessing is carried out to elite outlets firstly. Pearson correlation analysis and moving average method are used to analyze the characteristics of precipitation in Zhengzhou from 1973 to 2020 from the total amount, intensity and duration of precipitation. During this period, the climate average of total precipitation in Zhengzhou was 660 mm, the annual average precipitation intensity was 3.12 mm/d, and the top three years of total precipitation were 2003, 2016 and 1983 respectively. the number of light rain days in Zhengzhou is nearly 78 days, with a linear tendency of 0.34 d/a, showing a significant increasing trend; the number of moderate rain days is nearly 5 days, with a linear tendency of 0.02 d/a, showing an insignificant increasing trend; the number of heavy rain and torrential rain are nearly 4 days, and the linear tendency trends are 0.0008 d/a and 0.005 d/a, respectively, both of which show no significant downward trend.

References

[1] Meng Xiaojing, Chen Xin, Chen Jiajing, Yang Honggang. The application of combination weighting -TOPSIS in urban regional resilience assessment under flood disaster [J/OL]. Journal of Safety and Environment: 1-9 [January 14, 2023]. http://kns.cnki.net/kcms/detail

[2] Chen Jiaxin, Wang Juanle. Analysis and suggestions on defensive countermeasures of typical flood disasters abroad in recent years [J]. Disaster Reduction in China, 2022(21): 46-49.

[3] Shu Liangliang, He Xiaosai. Research progress of urban flood disaster risk assessment [J/OL]. Flood Control and Drought Relief in China: 1-6 [January 14, 2023]. doi: 10. 6867/ j. issn. 1673-19983. 100000000616

[4] Jin Ting. Study on the evaluation of urban flood resilience based on network structure model [D]. Wuhan University of Science and Technology, 2022. doi: 10.27380/d.cnki.gwkju.20000.100001000005

[5] Liu Jiafu, Zhang Yuxin, Wang Lili, Gao Xuan, Zhang Yuqi. Temporal and spatial pattern evolution and driving forces of flood disasters in three northeastern provinces [J]. Journal of Jilin Normal University (Natural Science Edition), 2022, 43(03): 129-140. doi: 10.16862/j.cnki.ISSN.

[6] Huang Yafei, Guan Zhaoyong, Cai Qian, Lv Chunyue. Analysis of temporal and spatial variation characteristics of rainstorm and flood disasters in Jiangnan area in recent 41 years [J]. Journal of Meteorology, 2021, 79(04): 582-597.

[7] Chen Chuanlei, Guan Zhaoyong, Xiao Guangliang, Cheng Pan, Yang Lei, Huang Hailiang. Temporal and spatial distribution of extremely long rainstorm in Liaoning Province and its impact system characteristics [J]. Journal of Meteorology and Environment, 2018, 34(02): 28-34.

[8] Yu Xuan, Xu Ying, Zhang Yongxiang. Temporal and spatial variation characteristics of rainstorm in China in recent 25 years and its impact on rainstorm and flood disaster [J]. Rainstorm Ddisaster, 2018, 37(01): 67-72.

[9] Wang Yi, Du Fu, Mao Rui. Possible impact of large-scale climatic factors on flood disaster in China in recent 40 years [J]. Journal of Beijing Normal University (Natural Science Edition), 2021, 57(06): 825-833.

[10] Ye Minghua, Chen Kang. Urban catastrophe risk: meteorological characteristics, loss status and optimization of management countermeasures-taking Zhengzhou "July 20" torrential rain and typhoon "fireworks" as examples [J]. Shanghai Insurance, 2021(08): 18-22.