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The spatial distribution of extreme precipitation in Tibet based on Pareto

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Abstract. The daily precipitation data of 1959-2017 years from May to September, with GPD and maximum likelihood method to under the laws and calculate the reappearance period values of heavy precipitation in Tibet. The results indicate that the daily precipitation of 28 stations in Tibet basically conforms to the model, and the theoretical frequency and the measured frequency are basically consistent. According to the spatial distribution of precipitation maximum value, the extreme values of Shigatse and Lhasa had large fluctuations, and the probability of record-breaking precipitation events was small. Precipitation extremes in the western part of Naqu region were relatively small, and the probability of record-breaking precipitation events was relatively high. The peak value of precipitation extremes in the flood season in Tibet generally showed a decreasing law from southeast to northwest, and the extreme value of the flood season reappeared in the southeast region was about twice that of the northwest region. The maximum rainfall in most areas will exceed 20mm in the next 5-10 years, and the maximum rainfall in Shigatse will reach 52.7 mm. After 15 years of recurrence in various regions, the peak rainfall growth in the flood season has become very slow.

1. Introduction

Regional extreme events (drought, high temperature, snow and ice) occur frequently under the background of global warming. Especially since 1980s, the extreme events had seriously affected the ecological environment, economic development and people's life. Extreme precipitation was one of the most concerned and affected natural disasters in the world. Many domestic and foreign scholars has carried out research on this.

Tibetan plateau has a special geographical location. It was a sensitive region of global climate change. The occurrence of extreme events has an important response to climate change for downstream. Therefore, it is necessary to study the pattern of extreme precipitation on the plateau and explore the predictability of extreme precipitation, so as to better predict extreme events and provide scientific basis for improving disaster prevention and reduction capacity.

2. Data and methods

2.1. Study area

Tibetan plateau, with an average altitude of 4000 meters, was a semi-arid monsoon climate in the temperate zone. From October to April of the following year was dry season. May to September, it was



the rainy season. Rainfall generally accounts for about 90% of the annual precipitation, and precipitation in various regions is also seriously uneven, gradually decreasing from nyingchi region to ali region.

2.2. Data

The daily precipitation data of 28 stations in the whole region from May to September in the last 50 years (1959-2017) was selected as the research object. Some sites started in 1965 and 1978.

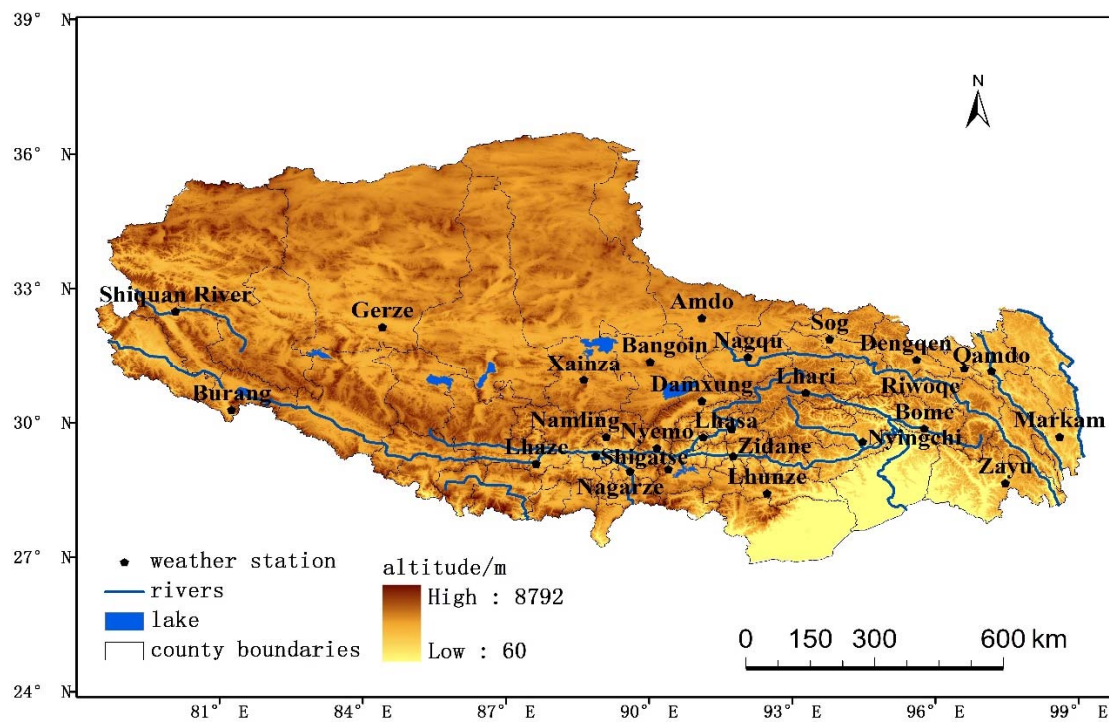


Figure 1. Location of study area

2.3. Methods

2.3.1. Density function and distribution function. GPD can directly use the original data over the years to set the threshold value artificially. After setting the threshold value, the maximum or minimum value exceeding this threshold value every year was extracted according to this standard, namely the "peak over threshold", which can improve the estimation accuracy.

$$f(x) = 1 - \left[1 - k \left(\frac{x - \xi}{a} \right) \right]^{1/k} \quad k \neq 0, \xi \leq x \leq \frac{a}{k}$$

2.3.2. Density function

$$f(x) = \frac{1}{a} \left[1 - k \left(\frac{x - \xi}{a} \right) \right]^{1/k - 1}$$

ξ : Threshold; a : Scale parameter; k : Shape parameter.

3. Results and discussion

The scale parameters mainly describe the variation rate of extreme value distribution. The larger of the scale parameters, the larger range of extreme value fluctuation. The average scale parameter of the extreme precipitation in Tibet was 6.07 ± 1.47 . The maximum value was located near Rigaze and Lhasa location. It indicates that the extreme value fluctuates greatly in areas. Because it were located in plateau monsoon area, and was affected by the Indian monsoon. The second high value area was located near nyingchi city. Because this region was located in the southern Tibetan valley, the elevation was lower than that of Lhasa, and the rainfall was correlated with the topography. The Indian Ocean monsoon is influenced by the mountains on the southern edge of the qinghai-tibet plateau during its northward movement, and the airflow moves northward along the lower Brahmaputra River and its tributaries. In the transmission process, it is hedged and violently uplifted at the great bend of the Brahmaputra River, resulting in abundant precipitation. The minimum scale parameters are located in the western region of naqu city.

As the second important parameter of the model, shape parameter represents different tail distribution characteristics of the model. The positive value area of shape parameter was located in areas such as bangor and ando, where the possibility of record-breaking precipitation event was higher than other areas.

The negative values of shape parameters were mainly in Rigaze and Lhasa along the river line. It indicates that the probability of precipitation breaking records in some regions was rvery small. Corresponding to the scale parameter distribution, the precipitation extreme value variable rate was large in areas along the river line and Nyingchi city, and the probability of breaking records was small. There were few precipitation days in the western part of Naqu region and the precipitation change rate was small. Once there has precipitation process, the extreme state is likely to be a record-breaking behaviour. It can be seen that the more frequent summer precipitation is, the less likely the extreme value will break the record. Because the climate probability of precipitation in arid regions is usually small, the probability of breaking records will be high.

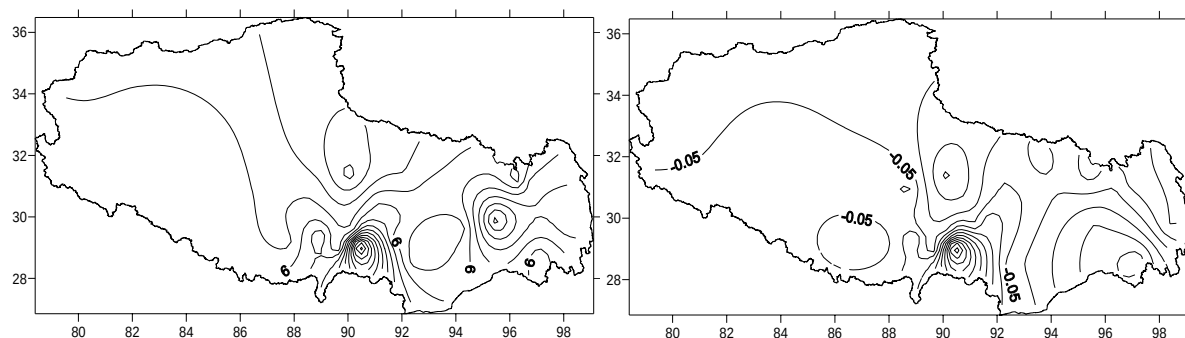


Figure 2. Distribution of scale parameters and shape parameters in Tibet

4. Conclusion

(1) Through the introduction of the GPD probability distribution model, the law of heavy precipitation in flood season in Tibet is simulated. The results show that the daily precipitation of 28 stations in Tibet basically conforms to the model, the theoretical frequency and the measured frequency are basically consistent, and the data length does not affect the statistical inference of the precipitation extreme value, and the longer the data age, the better the fitting result.

(2) The large-value areas of the scale parameters are located in Shigatse and Lhasa, respectively, indicating that the extreme fluctuations of the area are large; on the contrary, the small-value area is located in the west of the Nagqu area, indicating that the extreme value fluctuation is small. The positive value area of the shape parameter is mainly located in the Nagqu area, indicating that there is a high probability of occurrence of record-breaking precipitation events; the negative value area is mainly in

the Shigatse and Lhasa areas along the Yangtze River, followed by the stations in Changdu, where the probability of precipitation extremes is relatively small.

(3) The peak value of precipitation extremes in the flood season in Tibet generally shows a gradual decline from southeast to northwest. From the extreme values of the recurrence of flood seasons in 5 and 10 years, except for the Shiquan River (Ali area), the extreme rainfall in other areas Both are over 20mm, and the precipitation in Shigatse has an extreme value of 52.7mm. Lhasa and Nyingchi also have large extreme values. After the 15-year return period in each region, the extreme precipitation growth during the flood season has become very slow.

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