Rainy season change in Sanjiangyuan, China area based on the meteorological stations data

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Abstract. The Sanjiangyuan area is famous as the Chinese water tower, it is a transition zone of semi-humid, semi-arid and arid area. An area of about 400,000 square kilometers and the water source of billions of people, also the ecological barrier of the whole of Asia's economic and social development.Based on the daily rainfall data of 13 meteorological stations in Sanjiangyuan area from 1985 to 2015, the rainfall indexes such as the rainy season from the beginning and the ending of the rainy season were extracted. And the trend of rainy season in the study area was analyzed. The results show that the daily rainfall in the Sanjiangyuan area accounts for more than 50% of the annual rainfall; the onset of the rainy season in the eastern part of Sanjiangyuan has a delayed trend and the central area has a tendency to advance; the number of days in the rainy season has decreased in the past 30 years, reduced 4d. There is a positive correlation between the starting date of rainy season and the average rainfall in the rainy season. The changes of these rainy seasons are of great significance to the economic development and ecological protection of the region.

1. Introduction

Rainy season contains a lot of important phonological information, such as the beginning and ending of the rainy season, the number of rainy days, the number of intervals, the maximum rainfall, the average rainfall [1]. These indicators have been the focus of meteorological services and meteorological research [2]. Through these indicators we can know the rainy season in a region over the years changes in the situation, while these changes will affect the region's climate, ecology, economy, people's livelihood, etc. [3-5]. The Sanjiangyuan area is a transitional zone of semi-humid, semi-arid and arid areas. It is also a typical sensitive area of the climate change. It is a fragile area of geographical environment change [6]. The impact of changes in the rainy season is much greater, will

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profoundly affect the whole of China and the global climate change. The area has important geographical and geographical advantages in the Belt and Road. It not only has rich mineral resources, water resources, or an important ecological barrier, it is the main transportation hub linking east and west, getting through the north and south and connecting the whole Asia. Therefore, the development of the region and the ecological protection work will be the focus of connecting China and the West. We use the daily rainfall data of 13 meteorological stations in the study area to extract the phonological indexes of rainy season in the past years and analyze their temporal and spatial changes, and provide scientific guidance data for the infrastructure construction and ecological protection in this area.

2. Materials and methods

In this study, the precipitation data of 13 meteorological stations in Sanjiangyuan area from 1985 to 2015 were used to extract and analyze phonological indexes of rainy seasons in the study area from the meteorological data service network of China(http://data.cma.cn/site/index.html). According to the Qinghai Province announced the rainy season to determine the standard C1.5 to determine the annual rainy season [7]. Which, C5, C10 and C15 are not less than 1.5 when the rainy day. The data of all the days in the whole year were collected from the rainy season, the number of rainy seasons and rainfall in the rainy season. The site in the study area distribution is shown in figure 1.The study area is divided into three parts: the east, middle and west, the east including the five sites of Banma, Jiuzhi, Henan, Xinghai and Dari. Qumalai, Qingshuihe, Yushu, Nangqian, Zaduo and other six sites are in middle; the west, including Wudaoliang and Tuotuohe .

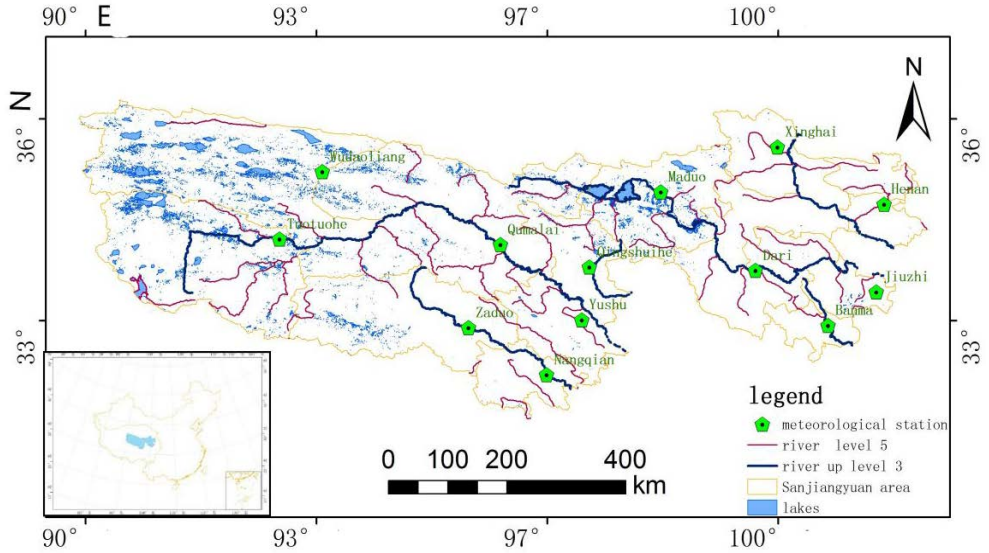

Figure 1. The study area distribution of meteorological stations

3. Results analysis

We will focus on the analysing of the annual precipitation in the rainy season and its proportion in every year; the starting and ending time of rainy season and the number of rainy days in each year; the relationship between the starting date of rainy season and the average daily rainfall in rainy season.

3.1. The beginning and ending of the rainy season

Wet and dry season, the region is clearly the beginning of the rainy season is one of the main features of seasonal conversion [6]. The precipitation relative coefficient C is used to determine the relative coefficient of rainy season and non-rainy season.

$$C = \frac{R(N)}{N} / \frac{R(Y)}{Y}$$

Where R (N) is the amount of precipitation in a certain period of time, N is the number of precipitation days for 5 days, 10 days and 15 days, and R(Y) is the average annual precipitation. The precipitation relative coefficients C5, C10, C15 were calculated for 5d, 10d, and 15d, respectively. The beginning of the rainy season standards: C5, C10, C15 ⩾ 1.5 [8]. The rainy season is determined to be the beginning rainy day when it was first time satisfy the condition throughout the year,. The last rainy season day is the ending of the rainy season. Since we determine rain relative use of the rainfall coefficient, the difference between the different sites may be larger.

Using a linear equation that to charge the trend of the rainy season from the beginning and the ending.

$$Y = a_0 + a_t$$

Form the linear trend term, at> 0 means that the rainy season has a delay trend since the beginning of the rainy season, at<0 indicates that the rainy season has a early trend, at × 10 means the trend of change every 10 years (units of d / 10a)[8]. Fig.2 shows the variation trend of the heterogeneous rainy season of the Henan and Zaduo. After the judgment of the rainy season over the past thirty years, we found that,the beginning of the rainy season of 6 sites including Zaduo, Yushu, Tuotuohe, Qumalai, Qingshuihe and Nangqian had a early trend, and the early trends were 5d, 1d, 4d, 2d, 1d , 3d, and the seven sites of Banma, Dari, Henan, Jiuzhi, Maduo, Wudaoliang, Xinghai had a delay trend, and delayed 1d, 8d, 5d, 7d, 11d, 1d. As the trend of the rainy season over the years in addition to the heterogeneous of Wudaoliang, Zaduo, Dari, Henan were delayed 5d, 8d, 2d, 2devery 10a, the other stations basically delayed trend, but the trend changes in the basic 1d every 10a. The rainy season beginning day advanced in the central area mostly,and delayed in the east .

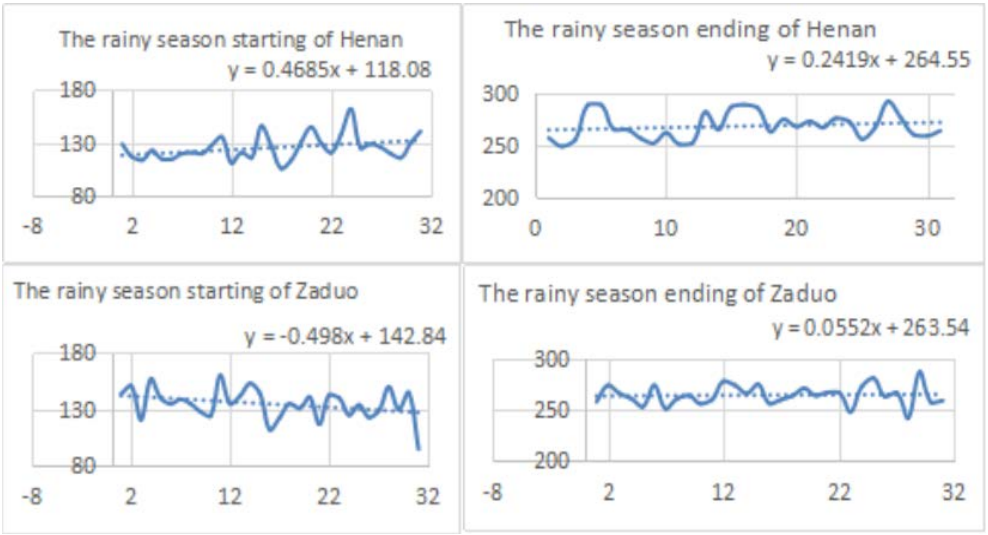

Figure 2. The trend of the rainy season starting and ending of Henan and Zaduo stations

3.2. Rainfall in the rainy season

Rainy season refers to the relative concentration of precipitation in a year. Only the dry and wet season in the Sanjiangyuan area, rainfall in the rainy season occupies a very high proportion in the annual precipitation [9]. Table 1 shows the annual precipitation in the rainy season, the average number of days in the rainy season and the trend of the rainy days in each year. It was found that only the rainy days (C ≧ 1.5) accounted for the lowest42% of the total precipitation in the whole year in Maduo, and the highest was 54% in Tuotuohe, with an average 50% of all. The most of rainy days in the Xinghai is 92 days. The average number of rainy days on all sites is 78 days, accounting for 21.4% of the whole year. That is, 78 days during the rainy season in the region daily rainfall accounted for half of the annual rainfall. It is found that all the 13 stations in the study area have a decreasing tendency in the

past 30 years, and the decrease of the Tuotuohe is the least, and the decrease of the Wudaoliang is the most.The average of all reduced 4 days every 10a.

Table 1. The annual precipitation, average number of days and the trend of the rainy daysin the rainy season

Station	Banma	Dari	Henan	Jiuzhi	Maduo	Nanhqian	Qingshuihe	Qumalai	Tuotuohe	Wudaoliang	Xinghai	Yushu	Zaduo
Rainy day rain ratio(%)	43.21	43.18	42.77	43.41	42.01	49.45	44.29	50.16	53.99	44.34	50.89	48.72	49.89
Rainy days(d)	78	73	74	80	71	79	75	80	75	79	92	82	79
Days change in rainy every 10 years（d/10a）	-7	-6	-3	-4	-3	-5	-5	-2	0	-9	-4	-4	-1

3.3. The relationship between the beginning of rainy season and rainfall

Many scholars have shown that the delay or early onset of rainy season will have an impact on rainfall in the rainy season [9-12]. We analyze the site rainy season starting date and the average rainy season rainfall. Table 2 summarizes the correlation (R) of the beginning of rainy season to the average rainy season for all stations. Among them, the correlation of Wudaoliang sites is 0.98, and the lowest is 0.32, the average is 0.58. Indicating that there is a positive correlation between the onset of rainy season in the study area and the average rainfall in the rainy season, that is, the rainy season will be delayed in the rainy season. This phenomenon can be based on the beginning of the rainy season this year compared with previous years, you can predict the rainy season this year, the size of the average rainfall, to guide the work carried out is significant.

Table 2. The correlation between the beginning of the rainy season to the average rainfall

Station	Banma	Dari	Henan	Jiuzhi	Maduo	Nanhqian	Qingshuihe	Qumalai	Tuotuohe	Wudaoliang	Xinghai	Yushu	Zaduo
Correlation（R）	0.57	0.68	0.49	0.47	0.68	0.61	0.32	0.39	0.38	0.98	0.81	0.69	0.53

4. Conclusion and discussione

4.1. Conclusions

During the rainy season, 21.4% of the rainfall in the rainy season accounted for 50% of the annual rainfall. The beginning of the rainy season in the eastern part of Sanjiangyuan has a delayed trend and the central region has an early trend. The number of rainy days in the study area has a tendency to shorten, and it is shortened by 4 days every 10 years in recent 30 years. There is a positive correlation between the beginning rainy season and the average rainfall in the rainy season.

4.2. Discussion

In this study, only the meteorological station rainfall data analysis of the study area during the rainy season, due to the less meteorological stations in the study area, to get the spatial distribution of precipitation in the study area also need to use remote sensing rainfall data.

Using a non parametric analysis method to analysis the variability in the rainy season will be an improvement.

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