Characteristics of Climate Change in Kangding City in Nearly 50 Years

He Ailin *, **Wang Xiao**

Sichuan Minzu College, Kangding 626001, China

Abstract Based on the statistical data of temperature and precipitation in Kangding City from 1960 to 2011, the variation characteristics of temperature and precipitation in nearly 50 years were studied. The results showed that in Kangding City, average temperature showed an increasing trend in nearly 50 years, which is consistent with global warming. Average temperature in Kangding City was stable from the 1960s to the 1990s but changed obviously in the 2000s. Precipitation in Kangding City tended to increase in nearly 50 years. Spring and summer precipitation increased synchronously, and autumn precipitation was five times more than winter precipitation.

Key words Climate change; Temperature; Precipitation; Kangding City

DOI 10.19547/j.issn2152 -3940.2019.04.002

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) shows that in the last 100 years, the global average surface temperature rose by 0.85 ℃. Current research on climate change focuses on changes in precipitation and temperature. Domestic experts have shown that the overall changing trend of temperature in China is consistent with that of global temperature, namely showing an increasing trend[1-3]. Under the influence of global temperature and other factors, precipitation in many areas of China showed a decreasing trend in recent 50 years. Many researchers used different methods to analyze climate change, and most studies were conducted at macro scale[4-6]. However, due to the complexity of topography, there are certain differences in temperature and precipitation in the same city and even in the same county[7]. These are particularly prominent in mountainous areas. In this study, based on the data of temperature and precipitation in Kangding City (a tourist city) during 1960 -2011, the characteristics of climate change in Kangding City in nearly 50 years were analyzed to put forward some suggestions for the tourism planning and development of Kangding from the climate point of view.

1 Brief introduction to the study area

Kangding City is located in the west of Sichuan Province and the east of Ganzi Tibetan Autonomous Prefecture. It is situated in the transition zone from the Sichuan Basin to the Qinghai - Tibet Plateau and the Yunnan - Guizhou Plateau. In the city, the highest altitude is 7 556 m, while the lowest altitude is 1 390 m, with the relative height difference of 6 166 m, and the average elevation is 4 526 m. It has a continental plateau and mountain climate. The extremely minimum temperature is -14.7 ℃, while the extremely maximum temperature is 28.9 ℃, and annual average temperature is 7.1 ℃. The city is located in the province's most famous north-west Xianshuihe fault zone, the north-east Longmenshan fault zone, and the north-south Anninghe fault zone.

2 Data source and processing

The statistical data of temperature and precipitation in surface meteorological stations of Kangding City from March 1, 1960 to February 1, 2011 were provided by China Meteorological Information Center (http://www.nmic.gov.cn). Individual missing data on a day were interpolated by the multi-year average on the day. Based on the daily data of temperature and precipitation, three sequences of data in various months, seasons and years were obtained. A year was divided into spring (March - May), summer (June - August), autumn (September - November), and winter (December - February).

3 Characteristics of climate change in Kangding City

3.1 Temporal variation characteristics of temperature

3.1.1 Annual variation. As shown in Fig. 1, annual average temperature in Kangding City averaged 7.08 ℃ in nearly 50 years. The maximum temperature 7.2 ℃ appeared in 2010, while the minimum temperature 6.8 ℃ appeared in 1960. The linear fitting equation of annual average temperature is $y = 0.002\,5x + 2.121\,3$, revealing that annual average temperature increased by 0.002 ℃ every 10 years, namely tending to increase slightly in nearly 50 years. In Kangding City, the annual average temperature fluctuated more greatly from 1960 to 1975 than the temperature after 1975. It showed an upward trend after 1975, and tended to be stable from 1985 to 1999.

Received: May 25, 2019 Accepted: July 17, 2019

Supported by the Project of Education Department of Sichuan Province, China (16ZB0365); Project of Sichuan Minzu College (XYZB18041SB).

* Corresponding author. E-mail: 1033815712@qq.com

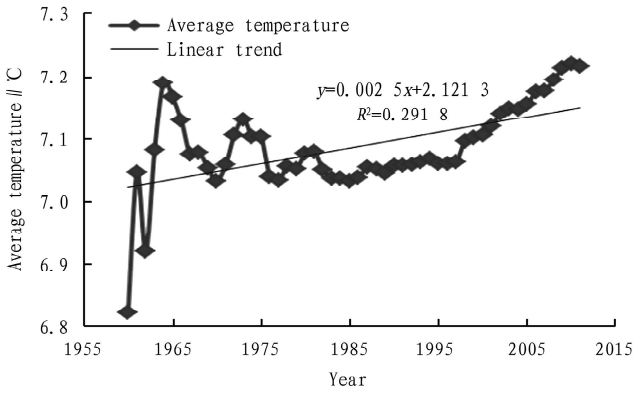

Fig.1 Annual variation of average temperature in Kangding City from 1960 to 2011

3.1.2 Interdecadal variation. According to Table 1, annual average temperature was stable from the 1960s to the 1990s but increased obviously in the 2000s. For spring average temperature, the minimum appeared in the 1990s, while the maximum appeared in the 1970s, and it reduced slightly in the 2000s, which is different from the changing trend of annual average temperature. Summer average temperature was the highest in the four seasons. It was higher than the average in the 1960s and the 2000s but lower than the average in the 1970s, the 1980s and the 1990s. Temperature change in autumn was similar to that in summer. That is, autumn average temperature was lower than the average in the 1970s, the 1980s and the 1990s but higher than the average in the 1960s and the 2000s. Autumn average temperature was the highest in the late 1960s and the lowest in the 1980s and 1990s. Winter average temperature tended to increase, and the minimum temperature −0.68 ℃ appeared in the 1960s, while the maximum temperature −1.14 ℃ appeared in the 2000s, and the difference between them was 0.54 ℃. It shows that winter average temperature increased obviously in nearly 50 years, which is consistent with global warming.

Table 1 Interdecadal variation of temperature in Kangding City ℃

Time	Annual average		Spring		Summer		Autumn		Winter	
	Temperature	Anomaly	Temperature	Anomaly	Temperature	Anomaly	Temperature	Anomaly	Temperature	Anomaly
1960 −1969	7.05	−0.02	7.42	0.03	14.65	0.03	7.66	0.11	−1.68	−0.30
1970 −1979	7.07	−0.01	7.45	0.06	14.56	−0.05	7.53	−0.02	−1.43	−0.04
1980 −1989	7.05	−0.03	7.39	0.01	14.57	−0.04	7.47	−0.08	−1.39	−0.01
1990 −1999	7.06	−0.02	7.31	−0.20	14.61	−0.01	7.47	−0.08	−1.27	0.11
2000 −2009	7.16	0.08	7.37	−0.01	14.67	0.05	7.62	0.07	−1.14	0.24

3.2 Temporal variation characteristics of precipitation

3.2.1 Annual variation. Seen from Fig. 2, annual average precipitation in Kangding City showed an increasing trend in nearly 50 years, increasing by 2.6 mm every 10 years, and the linear fitting equation of annual average precipitation is $y = 2.610\ 9x - 435\ 8$. The maximum precipitation 999.3 mm appeared in 1995, while the minimum precipitation 628.3 mm appeared in 1961.

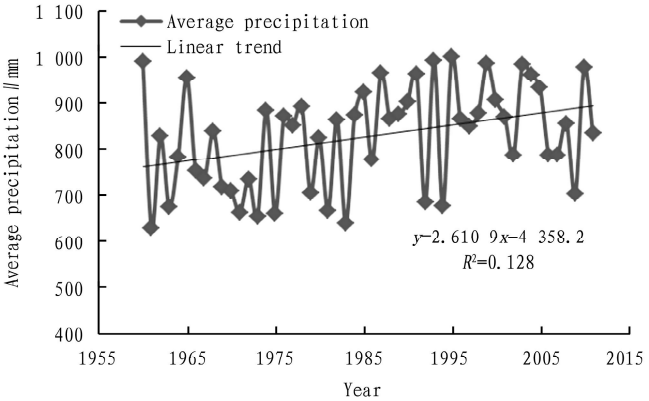

Fig.2 Annual variation of average precipitation in Kangding City from 1960 to 2011

3.2.2 Seasonal variation. Seen from Table 2, summer precipitation was the highest in the four seasons, accounting for 49.03% of annual precipitation. Spring and autumn precipitation were similar, accounting for around 24%. Winter precipitation was the least, accounting for only 2.67%. In a word, the precipitation in Kangding City was mainly distributed in spring, summer and autumn, accounting for 97.33% of annual precipitation, while there was nearly no precipitation in winter, which is consistent with the characteristic of rainfall in inland areas of China.

Table 2 Average precipitation in each season in Kangding City in nearly 50 years

Season	Average precipitation // mm	Proportion // %
Spring	200	24.27
Summer	404	49.03
Autumn	198	24.03
Winter	22	2.67

Seen from the linear fitting equation of average precipitation in each season (Fig. 3), the increases of spring and summer precipitation in Kangding City in nearly 50 years were basically equivalent, up to 1.02 and 1.08 mm/10 a respectively, which is different from the distribution of precipitation in Ganzi Prefecture and showed the characteristic of precipitation distribution unique to Kangding City. The minimum of spring precipitation 74.1 mm appeared in 1969, and the minimum of summer precipitation 238.3 mm appeared in 1961. The maximum of spring precipitation 314.9 mm appeared in 1984, and the maximum of summer precipitation 563.6 mm appeared in 1995. The increases were up to 240.8 and 325.3 mm, that is, the increase in summer precipitation was more obvious than that of spring precipitation. The increases in autumn and winter precipitation were 0.40 and 0.08 mm/10 a, that is, the former is fiver times

larger than the latter. It is clearly seen that the increase in autumn precipitation was more significant than that of winter precipitation, which is also in line with the characteristic of less rainfall in winter in China.

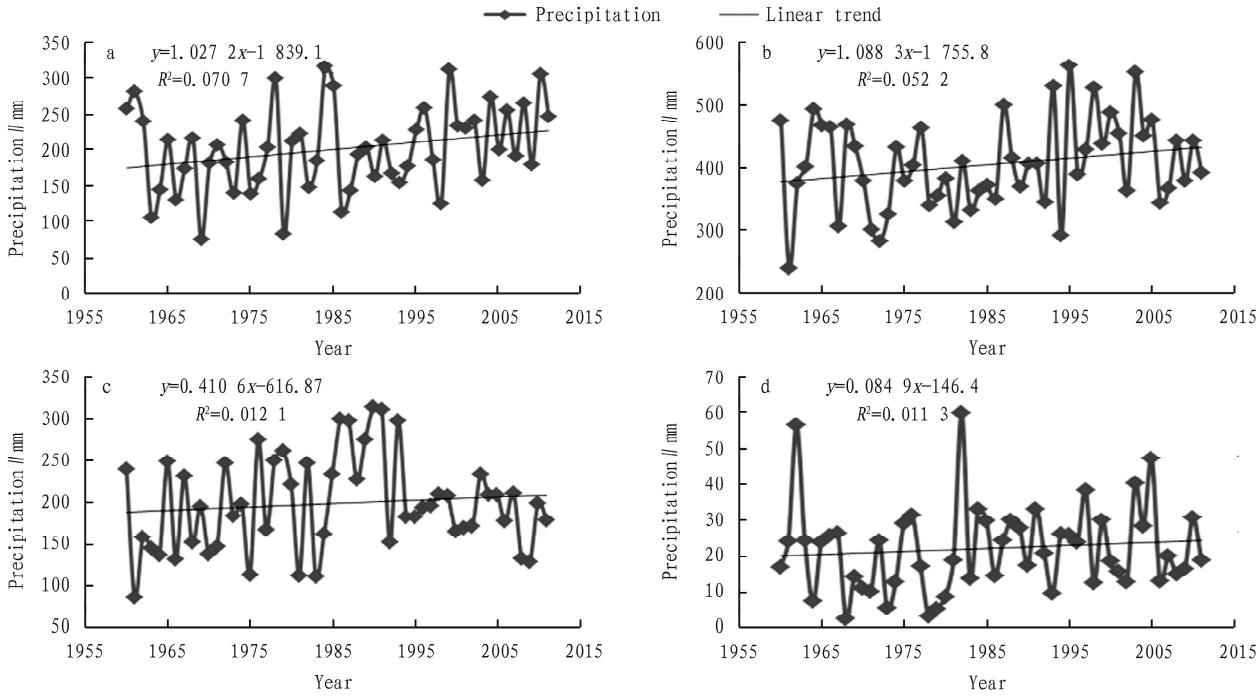

Fig.3 Changing trends of precipitation in spring (a), summer (b), autumn (c) and winter (d) in Kangding City from 1960 to 2011

4 Conclusions

(1) In Kangding City, average temperature showed an increasing trend in nearly 50 years (1960 –2011), which is consistent with global warming. Moreover, it was relatively stable from 1985 to 1999, and there was almost no change.

(2) Average temperature in Kangding City was stable from the 1960s to the 1990s but changed obviously in the 2000s. Spring temperature was similar before the 2000s. The interdecadal changes of summer and autumn temperature were similar, that is, they were lower in the middle decades but higher in the other decades. Winter temperature tended to increase gradually.

(3) Precipitation in Kangding City showed an increasing trend in nearly 50 years. Furthermore, spring and summer precipitation increased synchronously. Autumn precipitation was five times more than winter precipitation, which is basically consistent with the characteristic of climate in the mainland of China.

References

[1] SHEN YP, WANG GY. Key Findings and assessment results of IPCC WGI Fifth Assessment Report[J]. Journal of Glaciology and Geocryology, 2013,35(5): 1068 –1076.
[2] LIU X, LIU XW, RUAN ZL, *et al.* Impact of climate change on agro-meteorological disasters and pests[J]. Agriculture & Technology, 2015(2): 191.
[3] TIAN L, GAO QY, HAN Y, *et al.* Impact of meteorological disasters on agricultural production and preventive measures [J]. Southwest Horticulture, 2015(30): 218 –219.
[4] ZHANG DL, SHI KQ, CHANG S, *et al.* Effects of climate change on agro-meteorological disasters in Jinzhou area[J]. Journal of Agricultural Catastrophology, 2011(2): 52 –54.
[5] NIU JL, PENG J, WANG JQ, *et al.* Analysis of climate changing characteristics in Alar area from 1961 to 2013[J]. Journal of Arid Land Resources and Environment, 2016(1): 72 –77.
[6] WEI YL, HAN FX. Climate change characteristics of Nangqian County during 1961 –2013[J]. Science and Technology of Qinghai Agriculture and Forestry, 2015(1): 39 –44.
[7] ZHENG JG, YANG XM, ZHOU Y. Analysis of climate features of precipitation in Fuzhou City in recent 50 years[J]. Acta Agriculturae Jiangxi, 2014(9): 86 –89.

(From page 3)

[5] ZOU XK, ZHANG Q. Preliminary studies on variations in droughts over China during past 50 years[J]. Quarterly Journal of Applied Meteorology, 2008(12): 679 –687.
[6] JIANG XY, LIU SH, MA MM. A wavelet analysis of the precipitation time series in Northeast China during the last 100 years[J]. Geographical Research, 2009(3): 354 –362.
[7] LI C, XIAO ZN, ZHANG XL. Climatic characteristics of regions of China for precipitation in various the past 60 years[J]. Meteorological Monthly, 2012, 38(4): 419 –424.
[8] TANG GL, DING YH, WANG SW, *et al.* Comparative analysis of the time series of surface air temperature over China for the last 100 years[J]. Advances in Climate Change, 2009(3): 71 –78.
[9] YANG M, LI WL, LIU Y, *et al.* Characteristics of the climate change in West China in recent 50 years[J]. Quarterly Journal of Applied Meteorology, 2010, 21(2): 198 –204.