Analysis on the Change of Urban Heat Island Effect in East China

Keqi Zhao[1,a], Xiaoxiao Zhang[2,b,*]

[1] Nanjing NRIET Industrial Co., Ltd., Radar System Engineering Center, Nanjing, Jiangsu, 211106, China

[2] Nanjing University of Information Science and Technology, College of Liberal Arts, Nanjing, Jiangsu, 210044, China

[a] zhaokeqi@glarun.com, [b] oxygen07@126.com

*corresponding author

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Abstract: Using the data of temperature and precipitation in Xining, Datong and Huangzhong stations from 1986 to 2015, By linear regression, distance analysis and Mann-Kendall test, the effect of summer urban heat island effect on summer precipitation in Xining area was analyzed. Studies have shown that From 1986 to 2015, the intensity of urban heat island decreased in Xining city, the highest temperature contributes most to it. In the past 30 years, the summer temperature in Xining area has been rising significantly, The warming rates of mean temperature in Xining city, Datong and Huangzhong reached 0.7,1.0 ℃ /10 a and 0.5 ℃ /10, respectively The summer temperature in Xining city changed in 1997. Huangzhong had a mutation in 1994, Chase did not mutate. The summer precipitation and precipitation days in Xining urban area increased by 4.5 mm/10a and 1.2 d/10a respectively in recent 30 years. Chase's summer precipitation is increasing, The number of precipitation days is decreasing; The summer precipitation and precipitation days in Huangzhong are decreasing. The summer precipitation mutation in three stations mainly occurred in the 1990s, The city of Xining also mutated in 2000. There is a good correlation between the intensity and maximum temperature of summer maximum temperature and summer precipitation and precipitation days in urban area. Suburbs are also the best correlation between summer maximum temperatures and precipitation. The effect of urban heat island effect on precipitation is mainly due to the effect of prevailing wind direction and valley topography.

1. Research Background

In the last few decades, Socio-economic development has greatly accelerated the process of urbanization worldwide, And the development of industrialization and urbanization will inevitably have a great impact on the microclimate of the city[1]. In recent years, In climate change studies, There are many studies on the trend of warming, the warming range, the urban heat island and the causes of warming [2]. Climatic urban heat island, In essence, it is caused by the human factors of urbanization and local weather and climate change. Changes in underlying surface properties, anthropogenic heat source emissions, atmospheric environment and other factors will cause air temperature differences between urban and rural areas, And the temperature difference inevitably forces the local flow field to adjust, This may lead to differences in local weather and climate factors such as wind and precipitation, Differences in local weather and climate factors in turn have an impact on differences in temperature between urban and rural areas[3]. Daniel and other think, In the climate, Urbanization and industrial pollution will result in downstream rainfall and increased snowfall[4]. Jauregui and other think, The heat island effect enhances local convection in cities, thus triggering convective precipitation[4-5]. Sun Jisong and others studied the interannual variation of the urban heat island effect in Beijing and its effect on precipitation. The results show that the effect of heat island effect on precipitation and precipitation days shows different characteristics in winter and summer and different regions of the city[6]. studies such as weekly health indicate that Affected by urbanization, The frequency and annual precipitation of heavy rain and heavy rain in Nanjing area are increasing. According to studies, Temperatures in the Hexi

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Corridor have risen significantly over the past 57 years, Annual precipitation also showed a significant increase, overall to warm and humid[7]. A study by Wang Jianpeng, As the city grows, Xi'an has formed the obvious "heat island" centered on Xi' an in winter and summer [8]. By the interaction of heat island effect and seasonal variation of environmental wind field, The seasonal spatial distribution difference of precipitation is caused by the change of prevailing wind in winter and summer. All the above studies show that the distribution of meteorological elements (temperature, precipitation) is changed due to the urban heat island effect.

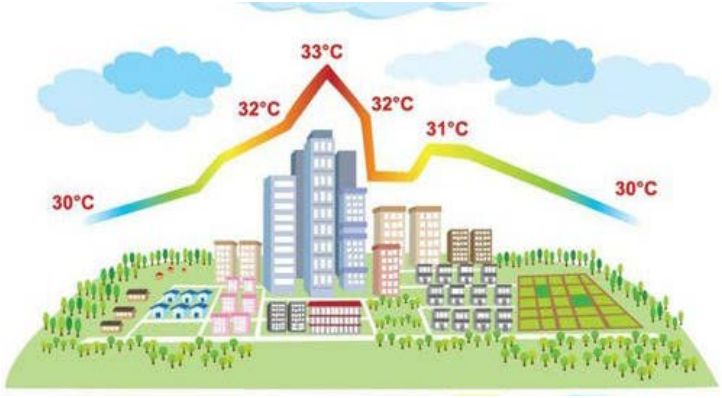

Figure 1 Heat island effect

2. Information and Methods

2.1. Overview of the Study Area

This paper studies the city heat island, Xining urban area as the city representative, Datong County and Huangzhong County as the suburban representative. Xining City is located in the transitional zone between Qinghai-Tibet Plateau and Loess Plateau. It is located in Hehuang Valley in the east of Qinghai Province. 665 km2, is a political, economic and cultural center and major industrial base in Qinghai Province. m, climate is a plateau continental semi-arid climate with an annual mean temperature of 7.6℃ and annual precipitation of 398.7 mm, rain and heat. Datong County and Huangzhong County belong to Xining City area, and Xining City in the same climate area. Datong is located in the southern foot of Qilian Mountains, north of Xining City, its north and west are high mountain areas, the terrain northwest high southeast low, average altitude 2 m.450 Huangzhong County is located in the west of Xining City. The terrain is high in the northwest and slightly lower in the southeast. m.668

2.2. Data Sources

To establish a stable climate data sequence, Ensuring consistency of meteorological data, Considering altitude, geographical location and urbanization, Selecting daily temperature and precipitation data of Xining city, Datong and Huangzhong from 1986 to 2015, Monthly, quarterly, annual, and data quality control. In statistics, The four seasons are divided into March-May for spring, June-August for summer, September-November for autumn, December to February of the following year for winter. To avoid, as far as possible, the omission of precipitation processes from relatively isolated mesoscale weather systems in summer, The daily precipitation $\geqslant$0.1 mm is recorded as one precipitation day. Meteorological data from Qinghai Meteorological Information Center. The basic information of meteorological stations in Xining area is shown in Table 1.

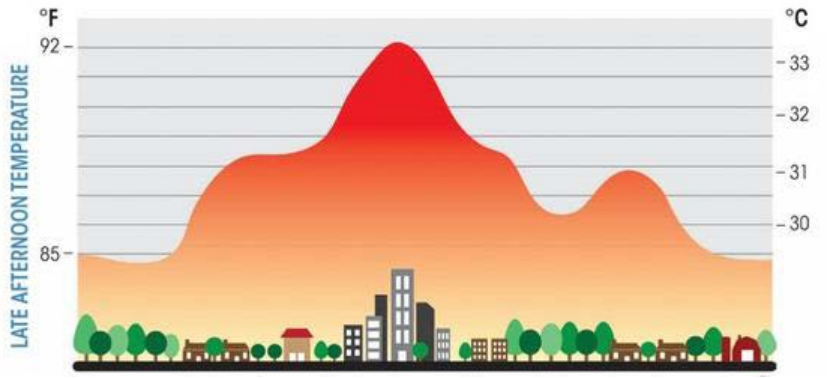

Figure 2 Heat island effect

2.3. Research Methodology

To eliminate the differences caused by altitude, the summer temperatures of the three stations from 1986 to 2015 were first revised uniformly to the average height of the plain area (398 m) according to the vertical decreasing rate of temperature (annual average ℃ per 100 m; summer :0.65 per 100).

Urban heat island intensity (unit :℃) and urban heat island effect (unit:%) in xining urban area, the calculation method is as follows:

[Tu=T Xining Tr=(T Datong Huangzhong)/2 Urban Heat Island Strength =Tu-Tr Urban Heat Island Effect Urban Heat Island Strength / Tu](1)

In the formula, [Tu] urban temperatures, That is Xining city temperature; [Tr] is suburban temperature. Following the practice of Zhou Mingyu and other [14], The urban heat island is defined as a strong heat island ≥2.0℃, ℃> urban heat island strength >0.5℃ is heat island, -0.5℃ ≤ Urban heat island strength ≤0.5℃ without heat island, -2.0℃< the intensity of urban heat island <-0.5℃ is cold island, Urban heat island strength ≤-2.0℃ is strong cold island. The urban heat island enhancement rate is the change rate of urban temperature minus suburban temperature, Unit ℃/10 a. Urban heat island effect is the proportion of heat island intensity to urban temperature, Unit is%.

In this paper, linear regression and distance analysis are used to reveal the effect of urban heat island on summer precipitation in Xining. In the analysis of the interdecadal variation of temperature, the difference between summer temperature, precipitation and precipitation days in 1986-1995,1996-2005 and 2006-2015 was taken. Using Mann-Kendall nonparametric test (M-K) to test the mutation of time series data, the significant level was set to 0.05.

3. Results Analysis

3.1. Changes in Summer Temperatures

First, Interannual variations in summer temperatures. Figure 1 shows the variation curve of the mean temperature, the maximum temperature and the minimum temperature in the summer of 1986-2015. Turns out, The average, highest and lowest temperatures in Xining are all on the rise. Of which, The mean temperature warming rates of Xining city, Datong and Huangzhong stations are 0.7℃1.0/10 a and 0.5℃/10 respectively The biggest square is Xining city, For 2.7℃, And then Chase is 2.3℃, Finally, the Huangzhong is 0.5℃, 30 years Zhongzhengping years Xining City a,27 Chase 21 a, Huangzhong only a;1 The maximum temperature increase rates in Xining city, Datong and Huangzhong are 0.8,0.7℃/10 a and 0.6℃/10 respectively The biggest square is Xining city, For ℃2.4, And then Chase is 1.8℃, Finally, it was 1.6℃, 25 a, in Xining City Datong and Huangzhong are 18 a;. The lowest temperature warming rates in Xining city, Datong and Huangzhong are 0.6,1.1℃/10 a and 0.5℃/10. The biggest square is Xining city, For ℃2.4, And then Chase is 1.5℃, Finally, it was 1.6℃, 18 a, in Xining City Datong and Huangzhong are 8 a and

15 a., respectively Visible, The increase of the maximum temperature in summer, the maximum of positive distance and the number of years of positive distance are all higher in urban areas than in suburbs.

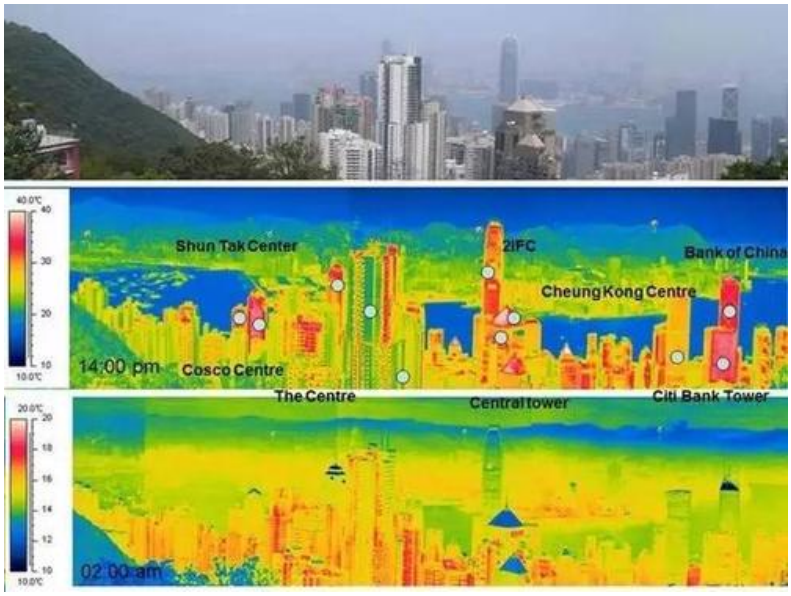

Figure 3 Heat island effect

Second, interdecadal changes in temperature. For nearly 30 years, The rising trend of summer temperature in Xining urban area is faster - faster - slower. During the 1990s and early 2000s, Particularly urban maximum temperature increases of 1.1℃/10 a. This is consistent with the conclusion reached by Shi Yafeng and others that the temperature rises rapidly in the northwest of China in the 1980s and 1990s. Meanwhile, The average and maximum summer temperatures in urban areas increased significantly between 2000 and 2010, This is related to Xining's rapid urbanization after 2000. It shows that the summer temperature in Xining area is obviously warming up due to urbanization and human activities. There's a consistent pattern of temperature rise in the suburbs, Fast - fast - slow, Two stations heated up dramatically in the 1990s, The increase in minimum temperature in Chase, in particular ℃1.4/10 a. Nearly 30 years, The interdecadal variation of summer mean temperature difference between urban area and suburb is large-small-large; The temperature difference between urban area and Datong is decreasing. And the temperature difference between urban area and Huangzhong is increasing slowly, maximum temperature difference is 0.4℃. Statistics show, By the end of 2015, The urban urbanization rate in Xining is 96.5%, The urbanization rates in Datong and Huangzhong were only 42.6% and 28.2%. Combined with Chase's warming trend, It shows that the acceleration of urbanization in recent years has increased the summer temperature of Chase significantly, In Huangzhong, where elevation is higher and urbanization is lower, warming is slower, So that the city's summer heat island intensity weakened.

3.2. Mutational Testing of Summer Temperatures

The M-K mutation point analysis method was used to test the summer temperature in xining from 1986 to 2015. the positive statistics UF curve and the reverse statistics UB curve of the temperature were plotted, and the significant level [α]=0.05 critical value precipitation [Z]=α]=1.96, as shown in figure 2.

4. Conclusions

Figure 2 shows that Xining urban UF curve was greater than 0 from 1986 to 2015. With the 1.96 confidence curve, It shows that the average summer temperature in urban area is increasing in the last 30 years. And after 1999 UF values exceeded the 1.96 reliability line, It shows that the

temperature rise in urban area is more obvious after 2000. The UF and UB curves intersect in 1997, And in the confidence curve, It shows that the summer temperature in Xining city changed in 1997. Chase's UF curve is 30 years greater than zero, From 1994, its UF value exceeded the reliability line, Huangzhong's UF curve was less than 0 in 1987 and 1993, Beginning in 1999 UF values exceeded the reliability line, That the temperature at Chase has been increasing over the last 30 years, The increase is more pronounced after 1994, And Huangzhong is 28 years show increasing trend, The increase has been more pronounced since 1999. The UF and UB curves of Chase have intersected over 30 years, But not between the confidence lines, indicating that there was no obvious mutation in the temperature of Chase. Thus, it was determined that the warming mutation appeared in 1994.

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