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Study on Climatic and Environmental Characteristics of Inner Mongolia Reach in Yellow River Basin

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Abstract

In this paper, taking the Inner Mongolia Reach of the Yellow River Basin as the research area, the meteorological data of precipitation, temperature, wind speed and pressure during 1995 2020 are analyzed by descriptive analysis, correlation analysis. The conclusions are as follows :(1) The average maximum daily precipitation of Etuoke Banner, Yikewusu Banner and Kangjin Banner in Inner Mongolia section of the Yellow River Basin from 1995 to 2020 is 34.812mm, which indicates that the total precipitation is insufficient. From 20to 20, the average precipitation was 219.5mm, the precipitation was more concentrated, and the average daily precipitation was 46.602 days ,that the number of days with precipitation was less.(2) The average temperature was in a stable trend during 1995-2020, and the average temperature from 2013 to 2020 was in a slow decline trend, but the temperature change was relatively small and the change was not obvious. The wind speed in the Inner Mongolia section of the Yellow River Basin has been decreasing year by year since 1995,and the maximum wind speed has been increasing since 2005. Average air pressure and precipitation at 20-20 hours have a significant positive influence on the number of daily precipitation 0.01 mm. The maximum atmospheric pressure and the maximum daily precipitation have a significant negative influence on the daily precipitation ≧0. 1mm.However, minimum air pressure, minimum air temperature, average 2-minute wind speed and maximum wind speed do not have any influence on the daily precipitation of 20.1 mm .

Keywords

Precipitation, The temperature, The wind speed, Internal flow area.

1. Introduction

1.1. Study purpose and significance

Since its birth, human beings have been closely connected with the geographical environment. Geographical environment is the guarantee of human survival. Geographical environment provides the necessary material materials for human society. The geographical environment with different conditions makes the human society embark on different roads. The Yellow River basin supports every aspect of people's lives. Under the joint action of climate change and human activities, a series of ecological and environmental problems have emerged in the Yellow River basin.[1]The climate-changing trend of warm and humidification. It has had a great impact on the Yellow River basin. Experts predict that the temperature in the Yellow River basin will also rise in the future,[2]Extreme weather and climate events have increased. Drought and water shortage, this phenomenon will not happen, too much to change, making the Yellow River basin in Inner Mongolia will face more severe ecological security risks. In the face of the current ecological problems and future ecological security risk challenges, many scholars of the Yellow River basin, but no scholars on the Yellow River basin in Inner Mongolia section flow zone climate study, so this paper is dedicated to the Inner Mongolia Yellow River flow zone meteorological data analysis, so that the relevant departments to take relevant measures to deal with climate change, make human society to deal with extreme weather and climate events and climate change, further improve people's ability to deal with risk. We will strengthen soil and water conservation and desertification prevention and control in Inner Mongolia in the Yellow River Basin, and strengthen water resources security and ecological civilization construction in the inner flow areas of the Yellow River Basin. It will help the relevant government departments to jointly tackle the challenges brought by the climate, and then ensure the ecological security of the Yellow River basin.

1.1.1. Status of domestic research

In order to improve the understanding of the long-term evolution law of long-term precipitation in China, Ren Guoyu et al. analyzed the national precipitation observation data from 1956 to 2013, and the results showed that the overall trend of precipitation was relatively stable. The floods in the south and the drought in the north are gradually alleviated[3]. In the middle and lower reaches of the Yangtze River, the precipitation increased not significantly, and the precipitation intensity decreased[4]. The precipitation on the Qinghai-Tibet Plateau decreased from southeast to northwest in 1980,2013. Annual precipitation increases year by year, and the number of annual precipitation days decreases day by day[5]. In the past 50 years, the temperature in northern China has increased significantly. The rate is up to 0.8℃ / 10 α[6]. On the basis of temperature observation data, combined with tree rings and historical data, Wang Shaowu et al. obtained the annual scale temperature sequence of 10 regions in China from 1880 to 1996. After calculation, the warming rate during this period is 0.44℃ / 100 α, which is significantly higher than the estimated value of 0.09 0℃ / 100 α. Relevant information of the western region is added to the new calculation process. There was also the rapid rise in temperatures in the 1990s[7]. Using the temperature observation data of mainland China starting in 1951, the temperature in China has increased by 1.3℃ in the past 54 years. On the whole, the warming of the Qinghai-Tibet Plateau and the northern part of China is obvious. In the northern part of Yunnan-Guizhou Plateau and Sichuan Basin, it showed the opposite cooling trend with the Qinghai-Tibet Plateau and northern regions[8]. The thermal and dynamic effects of the Qinghai-Tibet Plateau play an important role in the global climate change and atmospheric circulation. Thermodynamic action and dynamic action have attracted the attention of relevant scholars at home and abroad[9]. Temperatures on the Tibetan Plateau have risen significantly, and the warming rate is also higher than that in other parts of China. With the overall temperature rise, spring and winter increased the most in temperature[10]。

The evapotranspiration capacity under sufficient water supply conditions is reflected in the potential evapotranspiration, this value[11]. Regardless of meteorology and hydrology, potential evapotranspiration is always the key to affecting energy balance and surface water volume[12]. Evapotranspiration is a comprehensive transfer process of energy and mass between the surface and the atmosphere, and it is the most active mechanism connecting the atmosphere, biosphere, lithosphere and hydrosphere. The results show that the downward trend of potential evapotranspiration in southwest China is extremely significant. The annual PET mean values ranged from 451.2 to 1054.3mm. A decreasing trend from southwest to northeast. The PET is higher in the western Yunnan-Guizhou Plateau. PET in northeast China[13]. Scientists examined potential evapotranspiration trends in West Africa during 1906 – 2015. Trends and changes in potential evaporation over 110 years and two reference periods (19611990) were studied. The contribution of some climate elements (temperature, precipitation and cloud cover) to the changing trend of PET is analyzed. Long-term data analysis results showed complex PET trends in the three designated regions (Guinea, Savannah and Sahel). The trend in the PET changes varied significantly during the reference period. The PET trend decreased significantly in the first stage. The trend of PET in the second stage is significantly increased[14]. Based on the calculation results of potential evapotranspiration between 1960 and 2007, the national potential evapotranspiration decreased at a rate of 6.204 mm / l0 ɑ. The rate of the Yellow River basin is 1.092mm / l0 ɑ. The Songhua River basin rose at a rate of 3.775 mm / l0 ɑ. PET in the other eight basins all decreased, further indicating the universality of the "evaporation paradox"[15]. In time, PET mainly shows a decreasing trend in both the annual scale and the seasonal scale. From 1960 to 2020, there was a decreasing trend of 2.04mm / ɑ in the Haihe River Basin, with the largest decrease occurring in summer and the smallest decrease in winter. PET gradually declined from southeast to northwest[16]。

1.1.2. Progress in foreign research

Climate change has an impact on hydrology, biology, ecosystem, human society and economic life, so the benefits of climate change are extremely important to the development of different countries and even the world. Climate change changes the process of land surface and affects the system structure and function of hydrology and water resources. On this basis, it ultimately affects the development and utilization of water resources[17]。Under the joint influence of human activities and climate change, the study of environmental characteristics is an important research topic for global climate change, and also a challenge to global scholars. In order to promote the study of climate and environmental characteristics and carry out the investigation and analysis of climate elements,[18]Relevant global departments are cooperate on this theme. In terms of natural science foundation, WGI covers the observation results of all layers of the earth's land surface, makes the observation and cause analysis of climate change, and predicts the changes under different concentration paths in the future climate system. WGIII Mainly responsible for the assessment and detection of climate change mitigation. The release of the IPCC report plays an important role in the construction of human ecological civilization[19]. As an important part of the climate system, the hydrological cycle is restricted by climate on the one hand, and on the other hand will feedback climate on the other. The watershed hydrological cycle is largely affected by the conditions of its climatic system. The impact of global warming on precipitation is direct. The temperature increases increasing evaporation, drying the earth's surface, and increasing the intensity and duration of drought. More water holds in the air, leading to more water vapor in the atmosphere. Whether it is thunderstorms, snowstorms, or temperate precipitation, tropical cyclones, more intense precipitation events will occur. The balance of atmospheric and surface energy plays a critical role in the hydrological cycle. Despite little variation in wind speed and precipitation patterns, they still cause drier arid areas and wetter wet areas, especially in middle and high latitudes, which will continue into the future. In a warming climate, the risk of early spring flooding increases, and the risk of drought in the mainland also increases. The volcanic eruption in 1991 caused an unprecedented drop in land precipitation and runoff, with precipitation shifting from the land to the sea, causing widespread drought[20]. Through the output of observational data and climate models, Min et al. found that the precipitation pattern changed in the second half of the 20th century. This result suggests that human activities have triggered changes in the Arctic hydrology[21]. According to the precipitation data provided by the National Oceanic and Atmospheric Administration, the global precipitation increased by 1.9 percent in the last century, while the U. S. precipitation increased by 6.4070 (except for Hawaii and Alaska). Canada in 1970 – 2011 increased by nearly 2% – 3% compared to 1948 – 1970 precipitation. According to the observed precipitation data of more than 50 years in Calabria, both the annual precipitation and the autumn precipitation show a downward trend, while the summer precipitation shows an upward trend. During 1966-2005,60% of the 41 weather stations, mainly in northwest Iran, and seven of the four stations showed a clear downward trend. In addition, the trend of winter and spring precipitation was also mostly negative. The average increase was 0.12℃ per 10 years during 1951 – 2012. Heating up is evident in the middle and high latitudes in the northern hemisphere. Significant annual temperatures in the northwestern Himalayas between 1866 – 2006. The temperature in the winter is the four seasons[22]. US temperature spatial variation

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and the hydrological cycle. There is a statistically obvious inverse ratio between regional daily temperature trend and average daily precipitation[23]. Based on the reconstructed past regions and global temperature, Marcott et al. The early New century was warm, then dropped 0.7℃ by 5,000 years ago. This cooling is largely related to the near to 20.7℃ change in the North Atlantic. Past surface temperatures suggest that the recent warming is unprecedented[24]。

2. Overview of the study area

The specific geographical location of the Inner Mongolia section of the Yellow River basin is north latitude 37°26 '-40°50', between 104°59 '-110°10' east longitude, that is, from Shizuishan to Hekou Town of Inner Mongolia, with a total length of 830km and a basin area of 151,000 km2, A decrease of about 0.25%. The reach from Shizuishan to River is narrow with a total length of 126km; the plain valley channel from Dengkou to Hekou Town is about 546km; the plain is about 50km from north and the basin area is 76,000 km^2。

3. Research methods

3.1. Describe the analytical method

Description analysis used for, summarize the overall analysis of the study data. For example, how is the average air temperature and average air pressure studied in this paper;

3.2. The correlation analysis method

The correlation analysis method summarizes the relationship between each Y value and each X value, and whether there is a significant relationship between Y and X; the degree of relationship can also be reflected by the correlation coefficient.

3.3. Formula method

The temperature and precipitation data of the three meteorological stations in the Inner Mongolia section of the Yellow River basin from 1995 to 2020 are calculated as follows:

The annual average value of the temperature and precipitation in the Yellow River basin in the past 50 years. The calculation formula is as follows:

$$\bar{x}_n = \frac{1}{k}\sum_{i=1}^{k} x_i \tag{1}$$

$$\bar{x}_n = \frac{1}{k}\sum_{i=1}^{k} x_i \tag{2}$$

Where: n refers to the year, and k refers to the number of days.

The temperature and precipitation in the Inner Mongolia section of the Yellow River basin. The calculation formula is as follows:

$$\overline{x_{5n}} = \frac{1}{10}\sum_{n}^{n+9} x_n \tag{3}$$

Where: n refers to the year; 5n refers to the age.

4. Data sources

Meteorological data is the basis of the analysis, prediction and calculation of the meteorological information Material accuracy and its importance. The data of this study are mainly derived from:

(1) The missing data of the Inner Mongolia section of the Yellow River comes from the official website of the Yellow River

(2) Precipitation, temperature, wind speed and air pressure of Etok Banner, Ikusu and Hangjin Banner Meteorological Stations in 1995-2020 were downloaded from China Meteorological Data Network (http: / / data.cama.cn/)

(3) Precipitation and average precipitation from 20-20-20 in 1995-2020 are obtained from the daily value data set of China's ground meteorological data.

5. Results and analysis

5.1. Precipitation analysis

Table 1:Analysis of precipitation in Inner areas of Inner Mongolia in the Yellow River Basin

Basic indicators						
name	sample capacity	least value	crest value	average value	standard deviation	median
Precipitation at 20-20 hours	43	44.75	468	219.5	94.723	207
Daily precipitation is 0.1mm per day	44	23	71	46.602	13.768	43.75
Maximum daily precipitation	50	8.55	105.2	34.812	17.037	34.45

The Yellow River basin in Inner Mongolia is located in the northern temperate region, located in the northernmost end of the Yellow River, relative to other parts of the Yellow River, precipitation is relatively insufficient, as can be seen from table 1 ,1995-2020 the Yellow River basin in Inner Mongolia flag, wu su, HangJinJin maximum daily precipitation average 34.812mm, reached its peak in 199564.117mm, less precipitation. At 20-20 hours, the average precipitation is 219.5mm, the minimum value is 44.75mm, the maximum value is 468mm, the standard deviation is 94.723mm, the median is 207mm, the value exceeds the average maximum daily precipitation, indicating that the precipitation time is concentrated at 20-20 hours. From 1995 to 2020, the maximum daily precipitation of 0.1mm was 71mm, the minimum value was 23mm, the mean value was 46.602mm, the standard deviation was 13.768mm, and the median was 43.75mm. In 2003, the average daily precipitation of 0.1mm was 72 days, and the lowest value was 41 days in 2009.

5.2. Temperature change analysis

Table 2:Minimum temperature, highest temperature and average temperature of all stations in the Inner Mongolia section of the Yellow River Basin

Basic indicators						
name	sample capacity	least value	crest value	average value	standard deviation	median

minimum air temperature	43	-29.9	-18.05	-23.95	2.973	-24.15
maximum air temperature	50	33.1	39.1	35.718	1.499	35.55
mean temperature of air	49	6.5	9.85	8.229	0.704	8.15

Table 3:Percentage points of the lowest temperature, highest temperature and average temperature of each station in the Inner Mongolia section of the Yellow River Basin

name	minimum air temperature	maximum air temperature	mean temperature of air
P2.5	-29.89	33.128	6.6
P5	-29.6	33.2	7
P10	-27.76	33.81	7.45
P25	-26.3	34.475	7.725
P27	-25.948	34.654	7.775
P33	-25.322	34.949	7.825
P50	-24.15	35.55	8.15
P67	-22.504	36.6	8.55
P73	-21.988	36.7	8.758
P75	-21.9	36.725	8.825
P90	-20.04	37.745	9.1
P95	-18.63	38.597	9.375
P97.5	-18.09	39.045	9.775

Its average minimum temperature is-23.95℃, reaching its lowest temperature in 2012 and its maximum temperature of-19.6℃ in 2007; according to Table 2, the average temperature is 35.718℃, reaching its peak of 39.1℃ in 2017 and its minimum temperature of 33.1℃ in 2007. The average temperature maintained a stable trend from 1995 to 2020, with an average of 8.229℃, the lowest value of 6.5℃ in 1995 and a peak of 9.85℃ in 1998. From 2013 to 2020, in recent years, the average temperature is in a slow downward trend, but the temperature change is relatively small, and the change is not obvious. As can be seen from Table 3 that Cv values have the highest mean temperature, followed by the highest temperature and the lowest temperature.

5.3. Wind speed change analysis

Table 4:Maximum wind speed and average wind speed of each station in Inner Mongolia section of the Yellow River Basin

Basic indicators						
name	sample capacity	least value	crest value	average value	standard deviation	median
maximum wind velocity	50	10.35	20	13.951	2.252	13.425
Average 2-min wind speed	48	1.65	2.9	2.263	0.378	2.2

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The wind speed in the Inner Mongolia section of the Yellow River basin reached a wind speed of 17.2m/s in 1995. First decline and then rise, and reach the maximum wind speed value of 14.06m/s in 2020. The change trend of the average wind speed in 2 minutes is relatively consistent with the maximum wind speed image, the average value is 2.263m / s, the standard deviation is 0.378 m/s, and the median is 2.2 m/s. The average wind speed in 2 minutes is 2.1 m/s in 2004, and then shows an upward trend. After the average 2-minute wind speed in 2017, the average wind speed is 2.7m/s. According to the wind speed detected by the Etok Banner weather station, Ikusu weather station and Hangjin Banner weather station of the Yellow River basin, the wind speed in the Inner Mongolia section of the Yellow River basin is decreasing in recent years, but the trend of wind speed is less, which is within a reasonable fluctuation range.

5.4. Air pressure analysis

Table 5 Analysis of the minimum pressure, average pressure and maximum pressure of all stations in the Inner Mongolia section of the Yellow River Basin

Basic indicators						
name	sample capacity	least value	crest value	average value	standard deviation	media n
The lowest pressure	50	840.7	882.85	862.452	16.95	850.2
Average pressure	49	861.5	899.05	879.856	18.059	863.3
The highest pressure	50	877.4	962.45	900.69	21.874	884.5

The minimum pressure in the Inner Mongolia section of the Yellow River Basin is 840.7, the maximum value is 882.85, the average is 862.452, the median is 850.2, the standard deviation is 16.95, the smallest and the most stable. The highest pressure minimum was 877.4, maximum 962.45, mean 900.69, median 884.5, and standard deviation of 21.874 hPa. The mean pressure minimum was 861.5, maximum 899.05, mean 879.856, median 863.3 and standard deviation of 18.059 hpa. The lowest pressure, average pressure and highest pressure in the Inner area of the Inner Mongolia section of the Yellow River Basin were stable in the 25 years from 1995 to 2020, and the numerical fluctuation was very small, indicating that the pressure meteorological factor had little impact on the environmental characteristics of the Inner Mongolia section of the Yellow River Basin in the 25 years.

5.5. Correlation analysis

5.5.1. Analysis of days and air pressure of daily precipitation 0.1mm

Table 6:Correlation analysis of Pearson in the Inner Mongolia section of the Yellow River Basin

	Daily precipitation is 0.1mm per day
The lowest pressure	-0.795**
The highest pressure	-0.774**
Average pressure	-0.795**

* p<0.05 ** p<0.01

It can be concluded from Table 6 that the correlation between the daily precipitation of 0.1mm and the lowest pressure, maximum pressure and average pressure, respectively, was studied using Pearson's correlation coefficient. The specific analysis yields the following conclusions: (1) There is a level of 0.01 between the number of days of 0.1mm and the minimum pressure, and the correlation coefficient is-0.795, thus indicating that there is a significant negative correlation between the number of days of 0.1mm and the lowest pressure.

(2) The significant level of 0.01 is shown between the daily precipitation of 0.1mm and the maximum pressure, and the correlation coefficient value is-0.774, thus indicating that there is a significant negative correlation between the number of daily precipitation of 0.1mm and the maximum pressure.

(3) The significance of 0.01 between the Y variable and mean air pressure was shown, and the Pearson correlation coefficient was-0.795, thus indicating a significant negative correlation between daily precipitation of 0.1mm and mean air pressure.

5.5.2. Analysis of daily number and temperature of daily precipitation 0.1mm

Table7:Correlation analysis of Pearson in the Inner Mongolia section of the Yellow River Basin

	Daily precipitation is 0.1mm per day
minimum air temperature	-0.422**
maximum air temperature	-0.561**
mean temperature of air	-0.552**

* p<0.05 ** p<0.01

As can be seen from Table 7, correlation analysis was used to study the correlation between daily precipitation and minimum temperature, highest temperature and average temperature, and the correlation coefficient was used to indicate the strength of the correlation. Specific analysis shows that:The 0.01 level was significant with the lowest temperature, with a Pearson correlation coefficient value of-0.422, indicating a significant negative correlation between daily precipitation of 0.1mm and the minimum temperature.

A significance of 0.01 level was presented between the highest temperature, with the Pearson correlation coefficient of-0.561, indicating a significant negative correlation between daily precipitation of 0.1mm and the highest temperature.A significance of 0.01 was presented with mean temperature, with a Pearson correlation coefficient value of-0.552, indicating a significant negative correlation between daily precipitation of 0.1mm days and mean temperature.

5.5.3. Analysis of days and number of wind speed

Table 8:Pearson correlation analysis of the internal flow area of the Inner Mongolia section in the Yellow River Basin

	Daily precipitation is 0.1mm per day
maximum wind velocity	0.498**
Average 2-min wind speed	0.505**

* p<0.05 ** p<0.01

It can be seen from the above table that the correlation analysis is used to study the correlation between daily precipitation of 0.1mm days and maximum wind speed and average wind speed in 2 minutes, so that the analysis of Pearson correlation coefficient shows that:
(1) The correlation coefficient value between daily precipitation of 0.1mm and maximum wind speed is 0.498, which is significant at 0.01 level. This indicates a significant positive correlation between the daily precipitation of 0.1mm and the maximum wind speed.

The correlation coefficient value between the Y variable and the mean 2-minute wind speed was 0.505, indicating significance at the 0.01 level. This indicates that there is a significant positive correlation between daily precipitation of 0.1mm and mean 2-minute wind speed.

5.5.4. Analysis of daily precipitation 0.1mm days and precipitation

Table 9:Correlation analysis of Pearson in flow area of Inner Mongolia section in the Yellow River Basin

	Daily precipitation is 0.1mm per day
Precipitation at 20-20 hours	0.750**
Maximum daily precipitation	0.22

* p<0.05 ** p<0.01

As can be seen from the above table, the correlation between daily precipitation of 0.1mm and 20-20 hours, respectively. The specific analysis of the correlation coefficient shows that:

Daily precipitation of 0.01 was significant between 0.1mm and 20-20 hours, and the correlation coefficient was 0.750, thus indicating that there is a significant positive correlation between daily precipitation of 0.1mm and precipitation between 20-20 hours.

The daily precipitation of 0.1mm and the maximum daily precipitation is close to 0, and the p value is 0.151> 0.05, and the correlation coefficient value is 0.220, indicating that there is no correlation between the daily precipitation of 0.1mm and the maximum daily precipitation.

6. Conclusion

The annual average temperature of the Inner Mongolia section of the Yellow River basin for nearly 25 years shows the highest and low annual average temperature increasing year by year. From 1995 to 2020, the precipitation of the Yellow River basin changes most from 20 to 20, and the precipitation time is concentrated; the average temperature is generally stable from 1995 to 2020. From 2013 to 2020, the average temperature is in slow decline, but the temperature change is relatively small and the change is not obvious. The highest temperature and the lowest temperature in the Inner Mongolia section of the Yellow River basin were both stable from 1995 to 2020.1997 was the warmest year in the Inner Mongolia section of the Yellow River basin, and 1998 was the warmest year in the Inner Mongolia section of the Yellow River Basin. The wind speed in the Inner Mongolia section of the Yellow River basin has shown a downward trend year by year since 1995. Since 2005, the maximum wind speed has been rising. The wind speed in the Inner Mongolia section of the Yellow River Basin is in an increasing trend, but the trend of accelerating wind speed is less, which is all within a reasonable fluctuation range. The lowest pressure, average pressure and highest pressure in the Inner Mongolia section of the Yellow River Basin changed stable in the 25 years from 1995 to 2020, and the fluctuation was very small. Correlation analysis and summary analysis of linear regression method show that the average air pressure and the precipitation at 20-20 will have a significant positive effect on the daily precipitation of 0.1mm days. And the highest pressure, the maximum daily precipitation will have a significant negative effect on the number of daily precipitation of 0.1mm. However, the minimum pressure, minimum temperature, maximum temperature, average temperature, average wind speed of 2 minutes and maximum wind speed will not affect the number of daily precipitation of 0.1mm.

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