Impacts of climate change on hydrological cycle in the Yangtze River Basin Based on regression analysis

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Abstract. The climate change has a great impact on water resources in different regions of China, and has far-reaching impact on the construction of hydropower stations, dams, reservoirs and other water conservancy facilities. Based on the analysis of the influence of climate change on hydrological cycle in the Yangtze River Basin, this paper uses regression analysis model and geographic information system to analyze and study. The results show that climate has great influence on hydrological characteristics such as water vapor and precipitation in the Yangtze River Basin, and has certain value to ensure the social and economic construction of the Yangtze River basin.

Introduction

Water is the source of all plants and animals, it is indispensable to human survival and development of material resources. There are many water resources on the earth, but the water consumption and power consumption are serious around the world, and the water resources distribution is seriously unbalanced. The impact of climate change on water resources change is large, will directly lead to the change of water resources in time and space distribution, so the analysis and Research on climate change to impact on the hydrological cycle of the Yangtze River Basin, which has very important practical significance on the utilization of water resources planning for the future.

Regression analysis method

Regression analysis is a method of statistical analysis of data, its role is to determine the relationship between two or more than two variables interdependence theorem. First of all, it needs to get some data, then the data according to the mathematical formula derived general generality, then the promotion and application of these mathematical formulas, and then regression analysis, quantitative analysis on the relationship between the data of the relationship between the law, before a variable. In fact, in statistical relations, we tend to think that the variable y is affected by two factors: systemic and stochastic factors. The system factor is that if the argument is x, then the system factors can be expressed as $f(x)$ function form; secondly, the random factor influence the variable y to a great extent, generally represents the random disturbance factor. Therefore, we can model the regression model and get some data, and analyze the data, and establish the statistical model of dependent variable y and independent variable x.

Using regression analysis method to study the problem in general can be in accordance with the following steps: (1)Collect necessary data, (2) Collate and analyze the collected data, (3) Identify the goals of regression analysis, determine dependent variable, (4) Establishing regression analysis equation, (5) Make relevant analysis.

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Regression can also be classified according to the shape of regression, which can be divided into wired regression and nonlinear regression. The linear regression can be called linear regression, and nonlinear regression can also be called curve regression. Among them, linear regression is the most basic. A simple unary linear regression is introduced here, and the equation can be expressed as:

$$y = a + bx \tag{1}$$

In the formula (1): y is the dependent variable estimate; x is the independent variable; a is the constant of the regression equation; b is the slope of the regression line, also known as the regression coefficient.

According to the principle of least square method:

$$F = \min \varepsilon_i^2 = \min\left(y_i - a - bx_i\right)^2 \tag{2}$$

Combined with formula (1) and (2), the formula of regression can be deduced:

$$\begin{cases} b = \dfrac{n\sum xy - \sum x \sum y}{n\sum x^2 - \left(\sum x\right)} \\ a = \overline{y} - b\overline{x} \end{cases} \tag{3}$$

Hydrological characteristics of the Yangtze River Basin

The Yangtze River Basin is between 25 degrees and 36 degrees north latitude, and between 91 and 122 degrees east longitude. In the climate, most of the Yangtze River Basin belongs to the subtropical monsoon climate region, and the monsoon activity is affected by the precipitation in the Yangtze River basin to a great extent. In addition to the Tibetan Plateau in the western part of the plateau climate, the rest of the Yangtze River Basin is subtropical monsoon climate, the main feature of which is mild and humid, rainfall, four distinct seasons. These belong to the subtropical monsoon climate region average annual temperature is between 16~20 °*C*, in January the average temperature of the coldest is higher than °*C*, the average annual precipitation is about 1100mm, compared with the same latitude precipitation in the world, precipitation in the Yangtze River Basin area to be rich. The Yangtze River Basin area is very extensive, at the same time, the topography of the area is large, so the different climate characteristics of the basin are also differences. Generally, the Ganjiang River and Xiangjiang are the two most rainfall in the valley, more than 1500mm, the precipitation of Sichuan basin and the Hanjiang River in Xiangjiang and Ganjiang River Basin is not abundant, the precipitation is less in the middle reaches of Hanjiang River 1000mm. In addition, the precipitation will increase with the increase of topography.

Most of the Yangtze River Basin is located in the subtropical monsoon climate area, the precipitation is rich, over the years, the average precipitation of 1100mm. But due to the Yangtze River Basin involving area is very wide, involving the scope of the various landscape types, especially the upper reaches of the Yangtze River because of the large size of the Tibetan Plateau terrain, the characteristics of the monsoon climate affected, so in the Yangtze River Basin water fall within the space difference is big, the time course of changes is very complex. Therefore, the hydrological characteristics of the Yangtze River basin can be summarized as a few points:

(1) Sources of water vapor in the river

The water vapor in the Yangtze River Basin mainly comes from the India ocean, the bay of Bengal, the northern Gulf of South China Sea and the Pacific Ocean, and the southeast monsoon brings the basin into the basin. In recent years the average input precipitable water in Yangtze River Basin over the years up to 67800 billion cubic meters, of which about 4 of the water vapor in the

form of rain and snow fell to the ground, over the years the average depth of more than 1000mm, abundant water vapor in the Yangtze River Basin water environment plays a vital role.

(2) The spatial distribution of precipitation

In China, the distribution of annual precipitation shows a trend of decreasing gradually from southeast to northwest. In the southeast of the Yangtze River Basin, the annual precipitation can exceed 1200mm, and then in the northwest of the Yangtze River Basin, the annual precipitation can not even reach 500mm. Jiangxi east near Jingdezhen, Hubei and Western Hunan, Western Sichuan near Leshan and southwestern Sichuan Huili near the four area belongs to the rainy area, annual rainfall of more than 1000mm, they are not only the large amount of annual precipitation, and precipitation intensity is also great.

The distribution of precipitation is mainly due to the activity of the subtropical high in the North pacific. Once a year the summer monsoon is mainly with the North Pacific subtropical high northward, to the Yangtze River, when the summer monsoon from the southeast to the northwest wind direction, the summer wind carried by the vapor release along the way across time, so when the summer wind is advancing to the northwest, water vapor is less, so the precipitation in the southeast is abundant, while in the northwest direction is less. On the northwest of the machine itself is in a higher terrain, most of the altitude above the maximum precipitation belt, so the higher precipitation in the region less, the intensity is small.

In addition to the monsoon circulation characteristics that affect the formation of these four rainy regions, the terrain features and the underlying surface features also affect them. The formation of rainy climate in the vicinity of Leshan, Sichuan Province is mainly affected by topographic features. In the area of West Sichuan Leshan near the rainy south, there are things to Emei, Daxiangling, west south direction folder Jinshan, North Deng Xiashan, due to the mountains formed a special terrain east direction like "C", the special terrain can be uplifted to form air invasion. The cyclone "terrain rain", thus greatly improving the precipitation in these areas. The other three rainy zones also have this type of characteristics.

(3) The change of precipitation in time

Due to the monsoon climate, the precipitation in the Yangtze River Basin is obviously different from that in the rainy season and dry season in one year. The precipitation from May to October accounts for 70%~90% of the whole year. Also, due to the impact of the North Pacific subtropical high from the southeast to the northwest into the activities of the season precipitation time is also different, the lower reaches of the Yangtze River rainfall season generally in 4 to June, the upper reaches of the Yangtze River and rainfall season appeared relatively late, mainly in the 6 to August, the middle reaches of the Yangtze River is situated between the rainfall season the Yangtze River upstream and downstream, probably in May to July.

Because of the Yangtze Basin in warm humid monsoon climate zone, because the interannual variation of the volume is not particularly large, the relative rate of change in the 10% - 20%, compared with the north the Yellow River, significantly less than the change of precipitation in the Yellow River basin. Further analysis can be found in the Yangtze River Basin during the rainy season and the dry season, the relative rate of change between the various regions of the minimum and maximum distance flat appear in the rainy season, it shows that the rate of change of the dry season than during the rainy season change rate.

Impacts of climate on hydrological cycle in the Yangtze River

At present, there are many different methods to qualitatively predict and quantitatively evaluate the impact of climate change on surface runoff. In order to study the impact of climate change on

surface runoff in large scale and even global scale, it is a better way to connect macroscopic hydrological model and regression analysis model. The output of regression analysis model was used as the input of water balance model, which also considered the influence of soil type, plant type, precipitation, evaporation, runoff and rational use of land. Using geographic information system, each grid unit is regarded as a watershed and associated with the output of regression analysis model. According to the boundary of basin unit,

The average surface runoff in each watershed obtained from the surface runoff of each grid point in the basin is superimposed together to simulate the runoff variation in the Yangtze River Basin under multiple climatic scenarios, as shown in table 1.

Table 1 Changes of surface runoff in the Yangtze River Basin

River basin	Climate 1	Climate 2	Climate 3	Climate 4
Upper reaches of Yangtze River	In April to September increased significantly, and decreased significantly in November and December	Decrease in spring and increase in summer	Dongting Lake basin decreased in spring, and other increased	In August to December months increase
Middle and lower reaches of the Yangtze River	Most of them decreased in April to November	In April to November decreased, and increased in other months	In May to August months decreased, while other months increased significantly	In May to August months decreased

The results show that in the future possible climate in the Yangtze River Basin, surface runoff hydrological changes showed the following characteristics: in the upper reaches of the Yangtze River in summer and increase runoff, reduce runoff in spring; most of the year in the upper middle reaches of the Yangtze River, the total runoff is increased; runoff in the lower reaches of the Yangtze River summer and autumn is reduced, which is mainly depends on the different climate scenarios in different regions, but the number of summer runoff in the Yangtze River is increased obviously. The results show that the climate change in the Yangtze River basin runoff influenced the.

Conclusion

First a brief introduction of the regression analysis of this algorithm has been introduced in this paper, and then focus on the analysis of hydrological characteristics of space and time, water vapor source of the Yangtze River Basin on the precipitation distribution, using regression analysis model and geographic information system in the Yangtze River basin runoff for the change were analyzed. The results show that the climate has great influence on the runoff in the Yangtze River Basin, and the importance of the regression analysis model to the hydrological trend is verified.

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