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The Impact of Carbon Emissions on North-South Division of China-The Case of Huaihe

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Abstract: This paper explores the impact of carbon emissions on north-south division line in Huaihe section based on the analysis of the isotherms and rainfall. With the help of data analysis, an econometric model is established to analyze the relationship between the increase of carbon emissions and the movement of the north-south division line. The analysis shows that the increase of carbon emissions has increased the temperature and annual rainfall in Huaihe section, and the North-South demarcation line has moved northward.

Keywords: Carbon emissions; Isotherms; Rainfall; North-south division line.

1 Introduction

In recent years, the issue of carbon emissions has attracted the attention of many scholars [1, 2]. A large number of anthropogenic greenhouse gas emissions are important causes of climate change and serious natural disasters. The impact of carbon emissions on climate is multifaceted, and the change in the natural geographical transition zone related to climate warming is a subject worthy of study, which is of great significance for understanding and solving the climate problem [3].

The geographical dividing line between the north and the south of China, also known as the north and south climate dividing line, is the line of precipitation at 0 degrees centigrade and 800mm years in January, and also the dividing line of the distribution of the Dryland in the paddy field. There are two main climatic divisions in North and South China: the Qinling Mountains section and the Huaihe section [4]. Because of the mountainous area and high altitude in Qinling Mountains, the air circulation of the north and south slope of Qinling Mountains is blocked, so the climate change is not very significant; while the Huaihe section is located in the plain area, the air is unimpeded and the climate change is more remarkable [5].

The Huaihe section of the north-south division line is located in the eastern part of China, which stretches from Tongbai in the west to Sanjiangying in the east, and finally into the Yangtze River. The Huaihe line is generally consistent with the 0 DEG isotherm of January and the precipitation line of 800mm. It is the dividing line between the subtropical and warm temperate zones, and the dividing line between humid and humid areas. Huaihe is the boundary between the north and the south of China and the boundary of the climate. So it is absolutely representative to choose this area as the research object to explore the impact of carbon emissions.

As a climatic boundary of North and South China, the temperature and rainfall changes in Huaihe are closely related to global climate problems [6, 7]. In the last 20 years, with the increase of carbon emissions year by year, the climate change in Huaihe area is extremely remarkable, the temperature and rainfall are in the same direction, the temperature is increasing year by year, the rainfall is increasing year by year, and the humidification of the climate is becoming more and more significant. The change of temperature and precipitation in Huaihe basin can verify the effects of climate change in some respects [8, 9]. Based on this, the content of this paper is a subject worthy of being thoroughly studied.

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In this paper, the main reference values of two important indexes, the 0 DEG isotherm of January and the precipitation line of 800mm, are taken as the main reference values. Based on the data of nearly 20 years, the temperature changes and annual rainfall in the vicinity of Huaihe have been analyzed in the last 20 years, so as to understand whether the change of temperature and the annual precipitation change is apparent or whether the north and south climate boundary is shifted or not [10]. In order to predict the impact of future carbon emissions on the climate, we can predict the future North and south boundary movement through the model, and provide theoretical and practical basis for the development of low carbon economy [11].

2 Data

According to the distribution map of the north and South demarcation zone based on GIS, 8 important meteorological stations in Huaihe section are selected: Zhumadian, Fuyang, Suzhou, Bengbu, Xuyi, Huaian, Gaoyou and Sheyang (in order of longitude). The temperature and rainfall data in this paper are derived from the National Weather Bureau, and the temperature and rainfall in Huaihe area are collected and counted with the climatic data of various datum climates and basic meteorological stations. The data come from the National Meteorological Administration and the time scale of the data is 1997 - 2016, which can be seen in Fig. 1.

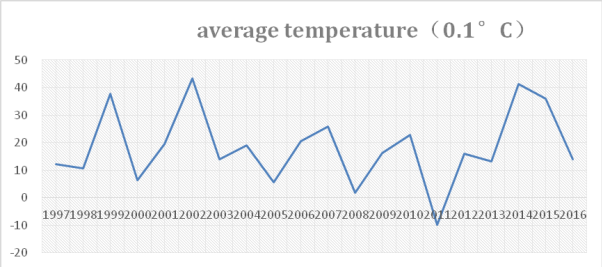

Figure 1: The average temperature chart of Huaihe basin in January

The average temperature in Huaihe section of Huaihe in January is up and down in January, the highest monthly average temperature is 4.3 degrees, the lowest monthly average temperature is -1 degrees, but the average temperature of most of the year is between 1 and 4. During the period of 1997 - 2003, the temperature fluctuated greatly, and there was a trend of rising. The temperature in 2003 - 2010 was more stable and lower than before, but the temperature began to rise again after 2011, and then began to decline after 2014. Compared with the average temperature in January and 2016 in 1997 and 2016, it can be seen that in the last 20 years, although the average temperature is constantly changing, there is a rise and fall, and the final average temperature is up 0.2 degrees centigrade compared with 20 years ago.

Based on the data of the National Meteorological Administration from 1997 to 2016, we can sort out the cities with an average temperature of 0 degrees centigrade for the last 20 years and get the actual change of the isotherm at 0 degrees in January. In this paper, the Huaihe area is only studied. Therefore, the city with the longitude between 110 E - 120 E and the average temperature in January is between -0.5 and 0.5 degrees, and the coordinates of each city are inquired.

From Fig. 2, we can see that in the last 20 years, the average latitudes of the cities with the average temperature of about 0 degrees centigrade in the last 20 years fluctuated around 34 N, and the latitude changed considerably in the 1997-2002 years and increased (the January isotherm moved northward), and the average latitude of 2002 to 2010 was stable, and was basically maintained at 34 degrees, 2011. The average latitudes began to rise sharply until 2015. Although latitude varies every year, it fluctuates only around 34 degrees N, so the average latitude varies little in 20 years. This is roughly the same as the change trend of the average temperature in January in Huaihe. Therefore, it can be considered that the actual January isotherm of 0 degrees is of reference value to the migration of Huaihe line.

With the aid of the statistical data of the National Meteorological Administration, the annual rainfall related data of 8 important meteorological stations in the Huaihe basin for nearly 20 years are extracted. In 2005, the annual rainfall data in Suzhou and Fuyang were obviously abnormal, and the two data are excluded. In order to get a clearer picture of climate change over the years, we give the line chart as shown in Fig. 3.

The annual precipitation in Huaihe period from 1997 to 2016 shows up and down trend around 1000mm, the maximum annual precipitation is 1400mm, the lowest annual precipitation is 650mm, but the annual precipitation in most years is between 800mm and 1200mm. During the period from 1997 to 2005, the annual precipitation fluctuated greatly, the

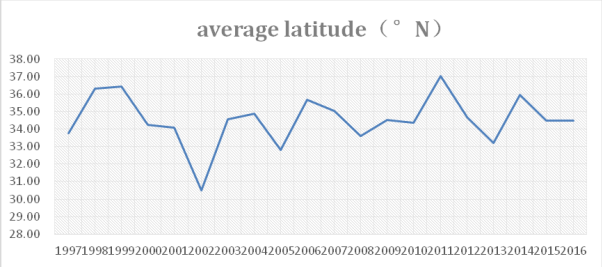

Figure 2: The average latitude of cities with an average temperature of 0 degrees centigrade in January

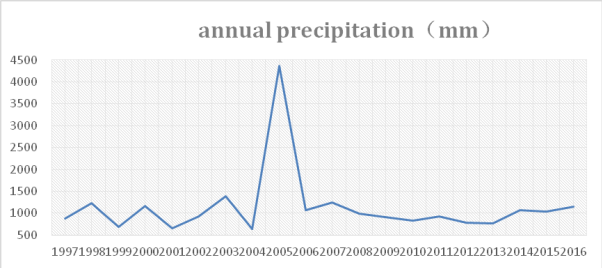

Figure 3: The annual precipitation curve of Huaihe area

precipitation gap between year and year was large, and the precipitation decreased slowly from 2005 to 2013, but the amplitude was small, and the annual precipitation after 2013 began to rise. Compared with the annual precipitation in 1997 and 2016, it can be seen that in the last 20 years, although the annual precipitation has been constantly changing, the annual precipitation has been rising and falling, and the final annual precipitation increased by 200mm compared with that of 20 years ago.

3 Empirical analysis

The 0 centigrade isotherm in January is an important indicator line for the north and south climate dividing line in China. As the boundary line between North and South and North and south, the Huaihe area is also the boundary line between the north and the south. The average temperature in the valley in January is basically maintained at 0. However, in recent years, the global temperature has been greatly increased by the influence of climate problems, and one month in the Huaihe area [12]. The average temperature is probably higher than 0 degrees, and there is a trend of increasing year by year.

In the past 20 years, the average temperature is not fluctuating around 0 degrees, indicating that the Huaihe area is no longer accurate as China's north south climate boundary. According to the specific data provided by the National Meteorological Administration, the specific coordinates of 8 important meteorological stations in Huaihe area can be obtained. The average latitude of the Huaihe area is about 32.85 N, while the average latitude of the 0 degrees isotherm in January is about 34 N. It is clear that Huaihe is no longer accurate as the north and south climate demarcation line in China. Because of the influence of climate, the temperature in China is also rising [13, 14], and the north and South climatic demarcation zone has moved northward, from the Huaihe area of Huaihe (32.85 degrees) to the present 34 N, and the span is 1.15 latitudes.

From the analysis of the average air temperature in January in Huaihe and the average air temperature of 0 degrees in January, we can see that the rise of the temperature is not local, but comprehensive. The rise of temperature caused the northward migration of the north and south climate boundary, resulting in the northward movement of the 0 centigrade isothermal line in January, which resulted in the average temperature of 0 degrees in the actual January.

In order to reflect the impact of carbon emissions on the 0 DEG isotherm of January directly, a simple two element linear regression model is set up. The model can predict the impact of the increase of carbon emissions on the 0 DEG isotherm of January, which has both theoretical and practical significance. There is a strong correlation between the

change of carbon emission and the latitude of the 0 DEG isotherm of January, so we take the carbon emission as the independent variable and the latitude of the January isotherm in January as the dependent variable.

The econometric model for the impact of carbon emissions on the 0 degrees isotherm in January is as follows

$$lat = \beta_0 + \beta_1 carb + u \tag{3.1}$$

where *lat* represents the average latitude (*N*) of the 0 degrees isothermal city in January, *carb* indicates annual carbon emissions (100 million tons), and *u* indicates the error term. The least square regression result of this model could be seen in Fig.4.

regress lat carb

Source	SS	df	MS	Number of obs	=	20
				F(1, 18)	=	0.04
Model	0.092825508	1	0.092825508	Prob > F	=	0.8388
Residual	39.2103684	18	2.1783538	R-squared	=	0.0024
				Adj R-squared	=	-0.0531
Total	39.3031939	19	2.06858915	Root MSE	=	1.4759

lat	Coef.	Std.Err.	t	P>|t|	[95% Conf.	Interval]
carb	0.0048531	0.0235097	0.21	0.839	-0.0445389	0.054245
_cons	34.35446	0.9121599	37.66	0.000	32.43808	36.27084

Figure 4: Parameter estimation results

From Fig.4, we can get the sample regression function as following

$$lat = 34.3545 + 0.0049 carb. \tag{3.2}$$

It can be deduced that each increase of 1 million tons of carbon dioxide emissions will lead the North-South demarcation line to the north latitude of 0.0049 latitude. China is in a period of rapid development, and carbon emissions have not reached its peak [15]. We can infer that in the future, China's north-south climate demarcation line will still move northward.

In addition to the 0 degrees isotherm in January, 800mm and other precipitation lines are also important indicators of the north south climate boundary. Climatology generally believes that a line in 800mm area of annual rainfall can be used as the dividing line between North and south climate of China. The area of annual precipitation more than 800mm is south, and it is humid, while the area with annual precipitation less than 800mm is north, and the north is generally dry. The annual rainfall in Huaihe is around 800mm, which is generally regarded as the dividing line between North and South China. As carbon emissions continue to increase, the seriousness of climate problems will also affect the change of rainfall.

Based on the data analysis of the National Meteorological Bureau, we can see that the annual annual precipitation in Huaihe area is about 1000mm, not the traditional 800mm year precipitation line. According to the traditional statement, the actual 800mm year precipitation line should be in the north of Huaihe, thus the north and south boundary line should move northward from the north of Huaihe, that is, the north-south division line, which is in accordance with the previous inference - the 0 DEG isotherm in January.

The reason that the 800mm year precipitation line is moving northward is that the greenhouse effect is worsened by the excessive carbon emission in the main city. The rise of the temperature leads to a large increase in the evaporation of the ocean and the increase in the moisture content in the atmosphere, which forces the warm and wet air to accelerate to form and eventually form the rainfall. The increase in rainfall is conducive to the growth of crops, but global warming can easily lead to continuous rainstorm and flood disasters. Therefore, the increase of rainfall is not an absolute benefit.

Similar to the above analysis, the sample regression function about average annual rainfall and carbon emissions could be expressed in Eq. (3.3).

$$Precip = 943.5126 + 0.5898 carb \tag{3.3}$$

where *Precip* indicates the average annual rainfall of Huaihe belt (*ML*), *carb* represents annual carbon emissions (100 million tons).

In this model, the constant term indicates the annual rainfall when the carbon emission is the initial value. The coefficient before *carb* indicates increasing annual rainfall when the carbon emissions increase one unit. The model not only explains the relationship between carbon emission and annual rainfall, but also predicts the effect of the increase of carbon emissions on annual rainfall in the future, which is of certain practical significance.

It can be deduced that an increase of 1 million tons of carbon dioxide would lead to an annual increase of 0.5898 milliliters of carbon dioxide. In the next few years, carbon emissions would continue to increase, which means that the annual rainfall in Huaihe would continue to increase, and the climate would become wetter.

4 Conclusion

The change of temperature makes the north and south climate boundary northward to 1.15, and the trend of continuous migration to the north, and the analysis of annual rainfall in Huaihe area also certifies this result. China emits one hundred million tons of carbon dioxide per year, the North-South demarcation line will move northward to 0.0049 latitudes, and rainfall will increase by 0.5898 milliliters. In the last 20 years, the average temperature in the area of Huaihe has risen by 0.2 degrees centigrade, some of the years in the middle are fluctuating, and the average temperature of one month in 20 years is above 0 centigrade. It shows that the climate problem has been for a long time and has only been controlled temporarily, but it has also prevented the further deterioration of the climate problem, its essential problems have not been solved, and the climate problem is still still It exists and can not be ignored.

The problems caused by carbon emissions are multifaceted, the greenhouse effect brings the increase of rainfall, which greatly improves the probability of heavy rain and flood disasters, which is a challenge for any country and region. The change of paddy field dryland has changed the proportion of grain production, and there may be different degrees of food shortage in different regions. The North-South demarcation line is a warning and a challenge to China's climate problem. As a major developing country and a major emitter of greenhouse gases, China is crucial to the global process of tackling global climate change. The climate problem has existed for a long time. China should pay more attention to climate issues and let the boundaries back to Huaihe at an early date.

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