ISSN 2616-5775 Vol. 5, Issue 9: 77-81, DOI: 10.25236/AJCIS.2022.050912

Research on Carbon Emission Response Strategy for Zoning Area Based on Multiple Linear Regression

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Abstract: *In order to achieve Chinese "Carbon Peaking and Carbon Neutrality Goals" and provide strategies for global carbon emissions, this study explored the relationship between regional carbon dioxide emission concentration and various factors by establishing a multiple linear regression model. The result showed that the concentration of carbon emissions was estimated by an optimal combination of factors affecting carbon emissions, This is more effective and practical than estimating with only one influencing factor. Among them, the important factors affecting carbon emissions are factory density, vehicle exhaust emissions, vegetation coverage and population density. Finally, it makes a reasonable response strategy to the factors of high impact on carbon emissions, and hopes to promote the development of our low carbon transformation and sustainable development, which has outstanding strategic value and positive practical significance.*

Keywords: *Carbon Emissions, Carbon Peaking and Carbon Neutrality Goals, Multiple Linear Regression, Zoned Area, Coping Strategies*

1. Introduction

In recent years, climate change with global warming as its main feature has become a global environmental problem, which brings severe challenges to global sustainable development. In 2020, China put forward the strategic goal of "carbon peak by 2030 and carbon neutrality by 2060"[1]. With the integration of Carbon Peaking and Carbon Neutrality Goals (Hereinafter referred to as Goals) and "the Belt and Road"(Hereinafter referred to as B&R) development goals, China proposes to provide more low-carbon infrastructure and technology to countries along B&R, and boost the low-carbon transition of developing countries. In addressing the climate crisis and achieving sustainable development, the combination of these two objectives has outstanding strategic value and positive practical significance. At the same time, with the rapid development of geographic information technology, remote sensing technology and computer big data technology, green technology has become the background of B&R cooperation. The achievement of Goals depends on the joint efforts of all localities and levels. Therefore, exploring the relationship between carbon dioxide emission concentration in a certain region and various factors will not only help to formulate the carbon dioxide emission standard scientifically, but also get the leading factor of the carbon dioxide concentration in the region. It provides important basis for drawing up regional low carbon development strategy and relevant policies in the future.

2. Retrospective Review

At present, experts and scholars at home and abroad have used a variety of models to study the influencing factors of greenhouse gas carbon dioxide. Among them, factor analysis method is mostly used to explore the limiting factors of carbon dioxide emission. Feng Yu and Ma Junteng et al. established a factor analysis model to explore the reduction of agricultural carbon emissions and its restricting factors in the Yellow River region[2], Yang Renchao and Piao Huilan used factor analysis and cluster analysis to analyze the carbon perception characteristics of tourists in Guanmenshan National Forest Park, Liaoning Province[3], Some domestic and foreign scholars have also used STIRPAT model to study the influencing factors of carbon dioxide emission, He Xiaogang and Zhang Yaohui conducted an empirical study on the influencing factors of China's industrial carbon emissions based on STIRPAT model[4], Thio and Ellen et al. estimated the influencing factors of carbon emissions based on EKC hypothesis and STIRPAT model[5].

In general, there are many studies on the influencing factors of carbon dioxide emission, and the

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research models used are everywhere. However, there are few studies on exploring the influencing factors of carbon dioxide concentration by multiple linear regression model, especially in the context of such multiple influencing factors. There are still many experiences to be further explored in the study of the influencing factors of carbon emissions and the coping strategies of different influencing factors.

3. Experiment Design

3.1. Data Source

This research data collection mainly divided into two major categories of remote sensing data and the general data, such as remote sensing data in Table.1. include Carbon Dioxide concentration, Impervious Surface information, Vegetation Coverage and Water information in four aspects, General data include Population Density, GDP Per Capita, Precipitation, Humidity of the Air, Factory Density and Vehicle Emissions, The advantages of zonal research are that it is more convenient to collect the above data and provide more targeted and efficient coping strategies.

Table 1: Data Acquisition.

Remote sensing data	General data
Carbon dioxide concentration	Population Density, GDP Per Capita
Impervious Surface information	Precipitation, Humidity of the Air
Vegetation Coverage	Factory Density
Water information	Vehicle Emissions

Among them, carbon dioxide is an important anthropogenic greenhouse gas. Studies have shown that increasing carbon emissions are a major factor causing the current global warming. At present, the Gaofen data inversion method is mainly used to collect carbon dioxide[6]. According to the characteristics of GMI (the main atmospheric greenhouse gas monitor on Gaofen 5 satellite), atmospheric CO2 can be retrieved by using the optimization estimation method.

Impervious surface usually mainly refers to the surface that can prevent or slow down the infiltration of surface water below the surface, such as roof, asphalt, cement road, different from soil, vegetation and other natural surfaces. Its source data can be obtained from the data products of Chinese Academy of Sciences [7]. The BCI index is used to calculate the impervious surface information. In BCI formula (1), impervious surface will show a high positive value and vegetation will show a low negative value to distinguish other land characteristics, while bare soil will show a value close to zero and can be separated from impervious surface. (TC1 is the luminance component of K-T transform; TC2 is the greenness component of the K-T transformation; TC3 is the humidity component of K-T transformation respectively.)

$$BCI = \frac{\frac{H+L}{2} - V}{\frac{H+L}{2} + V} \qquad \begin{aligned} H &= \frac{TC1 - TC1_{\min}}{TC1_{\max} - TC1_{\min}} \\ V &= \frac{TC2 - TC2_{\min}}{TC2_{\max} - TC2_{\min}} \\ L &= \frac{TC3 - TC3_{\min}}{TC3_{\max} - TC3_{\min}} \end{aligned} \tag{1}$$

Vegetation coverage is an important index reflecting the level of forest resources and greening. It is generally regarded as an important evaluation factor of ecological environment, because plants absorb carbon dioxide through photosynthesis, so it has a significant impact on carbon dioxide concentration. At present, information extraction methods based on vegetation phenology mainly include ground observation method, remote sensing analysis method and model simulation method, among which remote sensing analysis method is the most widely used. However, it should be noted that due to noise, there are outliers in the calculated values, so this study needs to modify them. The vegetation coverage used in this study is based on the NDVI estimation model of previous studies [8].

$$FC = (NDVI - NDVI_{min}) / NDVI_{max} - NDVI_{min} \tag{2}$$

On the one hand, water information is precipitation, air humidity, etc., which can be directly obtained by consulting the monthly or annual average precipitation and humidity of the region. However, the water body information in this study mainly refers to rivers, lakes or coastal water bodies in this region. At

ISSN 2616-5775 Vol. 5, Issue 9: 77-81, DOI: 10.25236/AJCIS.2022.050912

present, there are many water body recognition methods based on optical remote sensing data [9], among which the multi-band operation method is one of the mainstream methods. This method mainly uses the operation combination between bands to build a mathematical model conducive to the identification of water body information and screen out the required water body information through the threshold. Similarly, after removing the noise effect, the water range of the area can be obtained, and then the area of the water in the area.

For other general data related to human geography, the methods of data acquisition and data calculation in this research are summarized by reviewing various literature materials, which will not be described here.

3.2. Modelling

This study proposes to use multiple linear regression model to explore the influencing factors of carbon dioxide concentration. In the multivariate linear regression, the dependent variable was greenhouse gas (CO2) concentration, and nine factors including Vegetation Coverage, Precipitation, Humidity of the Air, Water information, Impervious Surface information, Population Density, Factory Density, GDP Per Capita and Vehicle Emissions were selected as independent variables, as shown in Table.2. A multivariate linear regression model was constructed for them. The type, the X_1... X_9 is the independent variable; Y is the dependent variable; β_0...β_9 is the regression coefficient and Ɛ is the random error term.

$$Y = \beta_0 + \beta_1 X_1 + \ldots + \beta_9 X_9 + \xi \tag{3}$$

Table 2: Variable Name.

Variable Name	CK	Variable Name	CK
CO2	Y	Impervious Surface information	X5
Vegetation Coverage	X1	Population Density	X6
Precipitation	X2	Factory Density	X7
Humidity of the Air	X3	GDP Per Capita	X8
Water information	X4	Vehicle Emissions	X9

3.3. Research Methodology

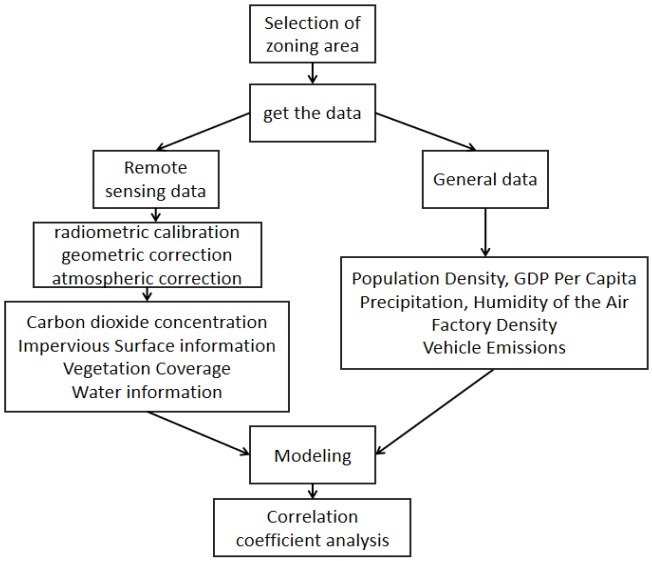

Figure 1: Flow Diagram of Experiment.

The process of this research is shown in Figure 1. Firstly, a certain regional environment is selected in China, and the remote sensing data and general data in this region are collected and acquired. The general data are obtained by summarizing various kinds of data and literature in this region, and the remote sensing data are preliminarily acquired through radiometric calibration, geometric correction and

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atmospheric correction. Then, the two kinds of data are taken as the data set of this experiment. According to the data set, the model of carbon dioxide and the other nine independent variables is established, and the partial regression coefficient of the model is obtained. Secondly, the correlation coefficient between each independent variable and the dependent variable carbon dioxide is calculated. Finally, the important factors affecting carbon emissions can be judged according to the correlation coefficient.

3.4. Research Summaries

In the establishment of multiple linear regression model, the partial regression coefficients of Factory Density, Vehicle Emissions, Vegetation Coverage and Population Density were positive. This indicates that they positively promote carbon emissions in the study area. As can be seen from the correlation coefficient of regression model in Figure 2., their correlation coefficients are all greater than 0.5, indicating that they are important factors affecting carbon emissions.

```
print('Correlation coefficient between independent variable and dependent variable: ')
van.bf.drop(['GDP Per Capita','Water Information','Impervious Surface Information',
             \'Precipitation','Humidity of the Air'], axis = 1).corrwith(van.bf.CO2)
```

```
Correlation coefficient between independent variable and dependent variable:
Factory Density:                    0.866070
Vehicle Emissions:                  0.762305
Vegetation Coverage:                0.573072
Population Density:                 0.537866
dtype: float64
```

Figure 2: Correlation coefficient of regression model.

From the analysis of experimental results, it can be seen that measures to deal with important factors affecting carbon emissions can effectively reduce carbon dioxide emissions. In terms of factory density, we should timely detect and regulate factories with excessive emissions, encourage the establishment of zero-carbon parks, strengthen information management and services, and achieve efficiency improvement and green manufacturing. In terms of vehicle exhaust emissions, the regional allocation of vehicle exhaust emission reduction targets will be carried out, clean fuel replacement will be promoted, and the "oil to gas" project will be implemented for buses and taxis. In terms of regional vegetation coverage, regional ecological protection should be implemented to increase the greening degree. We advocate planting trees and grass, introduce relevant policies, and strictly cut down and destroy grasslands. In terms of residential population density, we should make scientific plans for regional production, living and ecological space, and rationally allocate social resources.

4. Conclusions

In this research, the factors influencing carbon emission in a delimit area were explored, and multiple linear regression models were established. By calculating the correlation coefficient between the regional carbon dioxide concentration and other factors that may affect its emissions, a simple countermeasure summary is made for the high impact factors of carbon emissions. The regional experimental results show that there are still many challenges and changes on the way to achieve the Goals in China, and it is necessary to summarize, demonstrate and continue to reform the targeted experience, in order to make more contributions to the development of China's low-carbon strategy and achieve the Goals.

References

[1] Xu Zheng, Zuo Cheng-ji, Ding Shou-hai. Carbon Peak,Carbon Neutrality Empowers High-Quality Development: Internal Logic and Realization Path [J]. Economist, 2021(11):62-71.
[2] Feng Yu, Ma Junteng, Zhao Tingting. Analysis and Research on Agricultural Carbon Emission Digestion and Its Restricting Factors along the Yellow River Area Based on Factor Analysis Method [J]. Shanxi Agricultural Economy, 2022(03):130-132.
[3] Yang Renchao, Pu Huilan. Analysis of Forest Tourism Carbon Perception Characteristics of Tourists Based on Factor Analysis and Cluster Analysis [J]. Tourism Overview, 2020(20):29-31.
[4] He Xiaogang, Zhang Yaohui. Influence Factors and Environmental Kuznets Curve Relink Effect of

ISSN 2616-5775 Vol. 5, Issue 9: 77-81, DOI: 10.25236/AJCIS.2022.050912

Chinese Industry's Carbon Dioxide Emission-Empirical Research Based on STIRPAT Model with Industrial Dynamic Panel Data [J]. China Industrial Economics, 2012(01):26-35.

[5] Thio, Ellen, Tan, MeiXuen, Li, Liang, Salman, Muhammad, Long, Xingle, Sun, Huaping, Zhu, Bangzhu. Correction to: The estimation of influencing factors for carbon emissions based on EKC hypothesis and STIRPAT model: Evidence from top 10 countries [J]. Environment, Development and Sustainability, 2022(prepublish).

[6] YE Hanhan WANG Xianhua WU Shichao, et al. Atmospheric CO2 Retrieval Method for Satellite Observations of Greenhouse Gases Monitoring Instrument on GF-5 [J]. Journal of Atmospheric and Environmental Optics, 2021,16(03):231-238.

[7] Global 30 m impervious surface dynamic Remote Sensing products (1985-2020) website : https://zenodo.org/record/5220816#.YsZk5IRBw2w

[8] Xiaobing Li, Hong Wang, Huiling Long, Dandan Wei, Yun Bao. A model for the estimation of fractional vegetation cover based on the relationship between vegetation and soil moisture[J]. International Journal of Remote Sensing, 2012,33(11).

[9] Halder, Tanmoy, Chakraborty, Debasish, Pal, Ramen, Sarkar, Sunita, Mukhopadhyay, Somnath, Roy, Nishtha, Karforma, Sunil. A hybrid approach for water body identification from satellite images using NDWI mapping and histogram of gradients[J]. Innovations in Systems and Software Engineering, 2021(prepublish).