Environment, Resource and Ecology Journal (2022)
Clausius Scientific Press, Canada

DOI: 10.23977/erej.2022.060107
ISSN 2616-3756 Vol. 6 Num. 1

Ecological Area Planning Model Based on Multiple Linear Regression

Shijie Guo, Yonglin Huang, Yan Wang

Southwest University of Science and Technology, Faculty of Science, Mianyang, Sichuan, 621010, China

Keywords: Multiple linear regression, Ecological area planning, Carbon neutralization

Abstract: This paper choose four major indicators of urban precipitation, degree of desertification, carbon emissions and dust weather as the criteria for selecting and establishing ecological zones in the country, so as to narrow the scope of the country and build the main framework. These areas were fitted with the ecological model of Saihanba in Chengde city to determine the geographical location and number of the proposed ecological area, and the scale of the proposed ecological area was determined by using the normal distribution

1. Introduction

Saihanba is located in the southeast edge of The Inner Mongolia Plateau. It bears the important mission of preventing sand source, protecting water source and maintaining ecological security for Beijing and Tianjin. Since the 1960s, saihanba Mechanical Forest Farm has created 74,690.85 hectares of forest in the area. After more than half a century of efforts, the world's largest artificial forest has been built in Saihanba. Saihanba plays an important role in resisting sand storms, protecting the environment and maintaining ecological balance and stability. In this paper, we extend the ecological protection model of Saihanba to the whole country and establish a mathematical model and collect relevant data to determine which geographical locations in China need to establish ecological zones, and determine the number and scale of the proposed ecological zones; Assess its impact on China's goal of carbon neutrality.

2. Model Establishment and Solution

2.1 Multiple linear regression

Linear regression is to use regression analysis in mathematical statistics to determine the quantitative relationship between two or more variables. Suppose we have a factor that $x_1, x_2, \cdots, x_k, k$, a linear relationship:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k + \varepsilon$$

N groups of observation values are obtained by n independent observations of y and $(x_{t1}, x_{t2}, \cdots, x_{tk}), t = 1, 2, \cdots, n$ $(n > k+1)$ at the same time, which satisfy the equation:

$$y = \beta_0 + \beta_1 x_{t1} + \beta_2 x_{t2} + \cdots + \beta_k x_{tk} + \varepsilon_t$$

Among them, uncorrelated are random variables with the same distribution. To express the above equation with a matrix, let:

$$Y = X\beta + \varepsilon$$

Using the least β square method

$$\hat{\beta} = (X^T X)^{-1} X^T Y$$

Where, $(X^T X)^{-1} X^T$ is called the pseudo-inverse of X

Slope b:

$$u(b) = \frac{\delta}{\sqrt{\sum (x - \bar{x})^2}}$$

2.2 Geographical location selection of ecological area

Linear regression analysis of saihanba ecological model in Chengde City. The formula for the model is as follows: y=-0.0+0.083* Forest stock/ten thousand cubic meters. From F inspection results of the analysis can be obtained, significant P value is 0.0 * *, level is significant, refused to regression coefficients of 0 null hypothesis, the fit of the model of 1.0 at the same time, the model performance is relatively good, so the model of basic meet the requirements. For variable linear expression, all less than 10 2 VIF is based, so the model without multicollinearity problem, the model is well constructed. So the ecological model of Saihanba in Chengde city can be used as the fitting standard to select the national proposed ecological zones.

Through the analysis of the areas prone to dust weather in China, we have preliminarily selected two triangle areas.

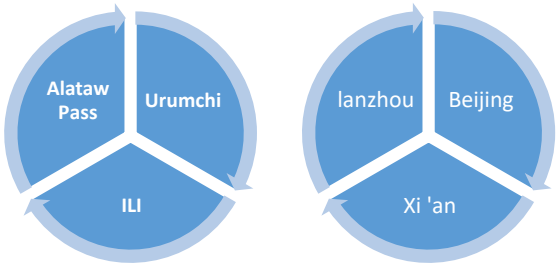


Figure 1: Dust weather region in China

Further screening of essential water resources according to the establishment of ecological protection areas. Through the second index of precipitation, 7 major cities that basically meet the planting demand in the two triangle regions are selected:

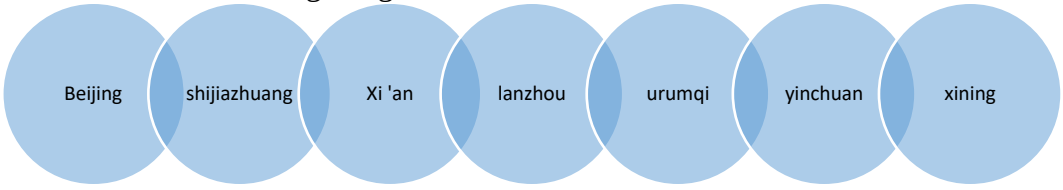


Figure 2: Cities meeting planting needs

The next screening based on China's carbon neutrality goals. China's carbon neutrality target announced by the state is 10 billion tons nationwide.

Then

$$\frac{\text{A national carbon neutral goal}}{\text{Total land area of China}} = \frac{\text{Ten billion tons}}{\text{9.6 million square kilometers}} = 1041.667 \text{tons/square kilometers}$$

According to this standard, the cities with excessive carbon are:

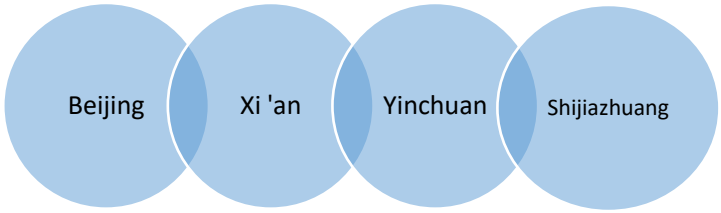


Figure 3: Cities with excessive carbon emissions

Considering the land resources and economic development strategy of Beijing, it is not practical to build an ecological model similar to Saihanba due to its geographical location and national status, although other indicators are met in Beijing. Therefore, Beijing is artificially excluded. The following three cities are only xi 'an, Yinchuan and Shijiazhuang.

2.3 Solving the model

(1) Firstly, the environmental conditions of Shijiazhuang and the ecological environment of Saihanba are analyzed by linear regression

线性回归分析结果 n=21

	非标准化系数		标准化系数	t	p	VIF	R^2	调整R^2	F
	B	标准误	Beta						
常数	-8305.745	540.989	-	-15.353	0.000	-	0.927	0.923	F=239.535 P=0.000
time	4.172	0.270	0.963	15.477	0.000	1.000			

因变量：C

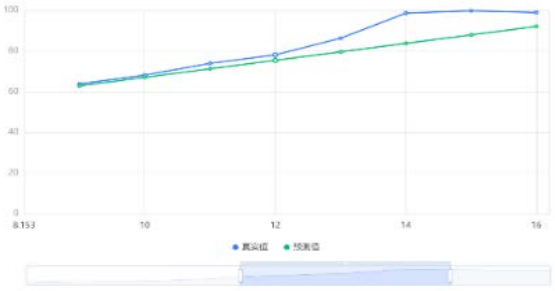
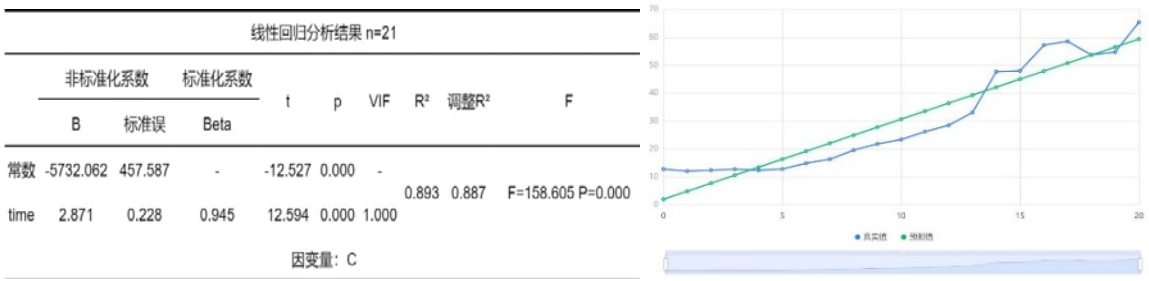


Figure 4: Linear regression analysis of Shijiazhuang

The formula for the model is as follows: y=-8305.745+4.172*time

From F inspection results of the analysis can be obtained, significant P value is 0.0 * *, level is significant, refused to regression coefficients of 0 null hypothesis, the fit of the model of 0.927 at the same time, the model performance is relatively good, so the model basic meet the requirements for variable linear performance, all less than 10 2 VIF is based, so the model without multicollinearity problem, The model is well constructed.

(2) Then the environmental conditions of Yinchuan and the ecological environment of Saihanba are analyzed by linear regression



线性回归分析结果 n=21

	非标准化系数		标准化系数	t	p	VIF	R^2	调整R^2	F
	B	标准误	Beta						
常数	-5732.062	457.587	-	-12.527	0.000	-			
time	2.871	0.228	0.945	12.594	0.000	1.000	0.893	0.887	F=158.605 P=0.000

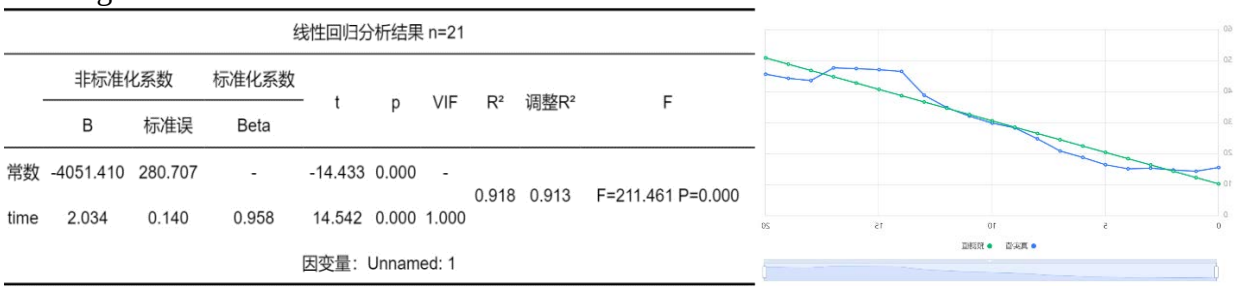
因变量：C

Figure 5: Linear regression analysis of Yinchuan

The formula for the model is as follows: y=-5732.062+2.871*time

From F inspection results of the analysis can be obtained, significant P value is 0.0 * *, level is significant, refused to regression coefficients of 0 null hypothesis, the fit of the model of 0.893 at the same time, the model performance is relatively good, so the model of basic meet the requirements of the variable linear expression, all less than 10 2 VIF is based, so the model without multicollinearity problem, The model is well constructed.

(3) Finally, linear regression analysis is made between the environmental conditions of Xi 'an and the ecological environment of Saihanba



线性回归分析结果 n=21

	非标准化系数		标准化系数	t	p	VIF	R^2	调整R^2	F
	B	标准误	Beta						
常数	-4051.410	280.707	-	-14.433	0.000	-			
time	2.034	0.140	0.958	14.542	0.000	1.000	0.918	0.913	F=211.461 P=0.000

因变量：Unnamed: 1

Figure 6: Linear regression analysis of Xi 'an

The formula for the model is as follows: y=-4051.41+2.034*time

From F inspection results of the analysis can be obtained, significant P value is 0.0 * *, level is significant, refused to regression coefficients of 0 null hypothesis, the fit of the model of 0.918 at the same time, the model performance is relatively good, so the model of basic meet the requirements for variable linear expression, all less than 10 2 VIF is based, so the model without multicollinearity problem, The model is well constructed.

(4) The size of ecozone is obtained from the maximum normal distribution:

Table 1: Ecological zone size

City	Size/m^2
Shijiazhuang	34159
Xi 'an	23872
Yinchuan	21298

3. Conclusion

Firstly, according to the four main indicators of urban precipitation, desertification degree, carbon emission and sand dust weather as the standard of national ecological region selection and construction, Shijiazhuang, Yinchuan and Xi'an are selected. Then, based on multiple linear

regression, the Saihanba ecological model of Chengde city is used to fit the above three areas to determine the geographical location and quantity of the proposed ecological area. Finally, the scale of the proposed ecological area is determined by using the normal distribution.

References

[1] Chen Shengdong, Xu Haigen, Cao Mingchang, Zhang Dangquan, Wu Weiwei Research Progress on species richness pattern [J] Journal of ecology and rural environment, 2011,27 (03): 1-9
[2] Tang Xiaoping, Luan Xiaofeng Building a nature reserve system with national parks as the main body [J] Forestry resource management, 2017 (06): 1-8
[3] Yang Rui on the environmental capacity of scenic spots -- Establishing the conceptual system of environmental capacity of scenic spots [J] Journal of urban planning, 1996 (06): 12-15 + 32-64
[4] Su Xin, Lin Jinfu "Limit of acceptable change" (LAC) theory and natural resource planning and management [J] Resources and production, 2010,12 (03): 109-112