Determination of the Amount of Disposableplastic Waste Based on Multiple Regression

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Abstract

Disposable plastic waste has been an urgent problem in environmental protection. Based on the multiple regression model, using ecological environment index EI as reference of environmental level, according to the source of disposable plastic waste, the method of plastic waste treatment and other factors, this paper build the regression equation of environmental status index and two influencing factors. Then with no further environmental damage as the constraint condition, the maximum amount of disposable plastic waste is obtained, and the reference Suggestions for the current plastic industry were put forward.

Keywords

Multiple regression, Amount of plastic waste, Environmental protection.

1. Introduction

Social resources and environment have always been the basis of human existence and development[1]. With the continuous development of society, people's demand for plastic products continues to expand, the plastic manufacturing industry is growing exponentially. However, as plastic is often a disposable products, the resulting waste of a large number of plastic waste is serious pollution of the global ecological environment, threatening the survival of human beings.

Therefore, in order to solve the plastic waste problem, save energy and protect the ecological environment, we need to slow down the amount of plastic waste, and improve the way we handle plastic waste, in order to reduce or even eliminate the waste of disposable plastic and its waste.paper.

2. Model

2.1 Model analysis

This paper needs to estimate the maximum amount of waste of disposable or disposable plastic products to ensure that no further environmental damage is caused. To solve this problem, the current global environmental level is represented by the ecological environment condition index EI, and the factors affecting the index are determined: the source of disposable plastic waste and the availability of the resources for disposing of plastic waste. Since the two influencing factors are related to the amount of disposable plastic waste, this paper establishes the regression equation of environmental condition index and the two influencing factors according to the multiple linear regression analysis, establishes the model, and obtains the relationship between the amount of plastic waste and the environmental level quantitatively. In the second step, the maximum amount of plastic waste is determined by the critical value of EI index according to the constraint condition of not further damaging the environment.

2.2 Model establishment

Multivariate linear regression is a theory that USES data to study the relationship between a dependent variable and two or more independent variables[2].

2.2.1 The relationship between the influencing factors and the amount of plastic waste

1. Source of waste: the source structure of waste is divided into living source, industrial source and agricultural source in this paper.

2. The availability of waste disposal resources: in this paper, the availability of waste disposal resources is divided into incineration treatment, landfill treatment and recycling treatment.

2.2.2 Establishment of equation[3]

(1) Multiple regression equation

$$\mathrm{EI} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_7 X_7 + e \tag{1}$$

$\beta_j (j = 0,1 \ldots ,4)$ is the partial regression coefficient, represent for the other independent variables remain unchanged, X increase or decrease a unit Y average variation.

e is the residual, represents the random error after the influence of four independent variables onY.

(2) least squares estimation of parameters

It can be determined by the least square method:

$$\widehat{EI} = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + \cdots + b_7 X_7 \tag{2}$$

$$\begin{cases} l_{11} b_1 + l_{12} b_2 + l_{13} b_3 + \cdots + l_{17} b_7 = l_1 \\ l_{21} b_1 + l_{22} b_2 + l_{23} b_3 + \cdots + l_{27} b_7 = l_2 \\ \cdots \\ l_{m1} b_1 + l_{m2} b_2 + l_{m3} b_3 + \cdots + l_{m7} b_7 = l_m \end{cases} \tag{3}$$

m is the number of samples of independent and dependent variables

$$b_0 = \overline{EI} - (b_1 \overline{X_1} + b_2 \overline{X_2} + b_3 \overline{X_3} + \cdots + b_7 \overline{X_7}) \tag{4}$$

(3) test of regression equation -- analysis of variance

① Make assumptions

H_0: There is no regression relationship between the independent variable X and the dependent variable EI

$$\beta_1 = \beta_2 = \cdots = \beta_7 = 0 \tag{5}$$

H_1: The independent variable X has a regression relationship with the dependent variable EI

Inspection level:$\alpha = 0.05$

② Calculate test statistics

$$\sum (EI - \overline{EI})^2 = \sum (\widehat{EI} - EI)^2 + \sum (EI - \widehat{EI})^2 \tag{6}$$

$$SS_{total} = SS_{regression} + SS_{residual} \tag{7}$$

$$SS_{regression} = b_1 l_{1Y_i} + b_2 l_{2Y_i} \tag{8}$$

$$SS_{residual} = SS_{total} - SS_{regression} \tag{9}$$

$$\mathrm{F} = \frac{SS_{regression}/7}{SS_{residual}/m-7-1)} \tag{10}$$

③ Judge the result

On the level of $\alpha = 0.05$, reject H_0, accept H_1, there is a regression relationship between independent variables and dependent variables.

④ evaluation of regression equation Decision coefficientR^2

$$R^2 = \frac{SS_{regression}}{SS_{total}} \tag{11}$$

$0 \le R^2 \le 1$,the number more close to 1 represent the sesult is more reaseanable; more close to 0,represent the result is not satisying。

Estimate the standard error

$$S = \sqrt{\frac{\sum_{k=1}^{m}(EI-\widehat{EI})^2}{m-7-1}} \tag{12}$$

⑤ test of regression coefficient

Make assumptions

H_0:$\beta_j = 0$， represent $X_j$has no relationship withEI.

H_1:$\beta_j \neq 0$， represet$X_j$has relationship with EI.

Calculate t:

$$t = \frac{\hat{\beta}_j}{S_{\hat{\beta}_j}} \sim t(m-7-1) \tag{13}$$

Determine the level of significance α：

$|t| > t_{\alpha/2}$,reject H_0； $|t| < t_{\alpha/2}$,accept H_0；

Identification and processing of multicollinearity of independent variables:

If the linear relation test (F test) of the model equation is significant, the regression coefficients of multiple independent variables fail the t test, or the t test is not significant, there is multicollinearity.

If there is multicollinearity between independent variables, the related dependent variables should be removed from the equation to avoid errors.

2.2.3 EI index

After the multiple linear regression equation of each environmental index is obtained, the environmental status EI index is obtained according to the weight, and the critical value specified in the world EI index specification when environmental damage is not caused is taken as the constraint condition, and the maximum consumption of disposable plastic waste is finally determined.

Table1. Environmental level specification table

level	A	B	C	D	E
EI	75≤EI≤	55≤EI≤74	35≤EI≤55	20≤EI≤35	EI＜20

3. Results

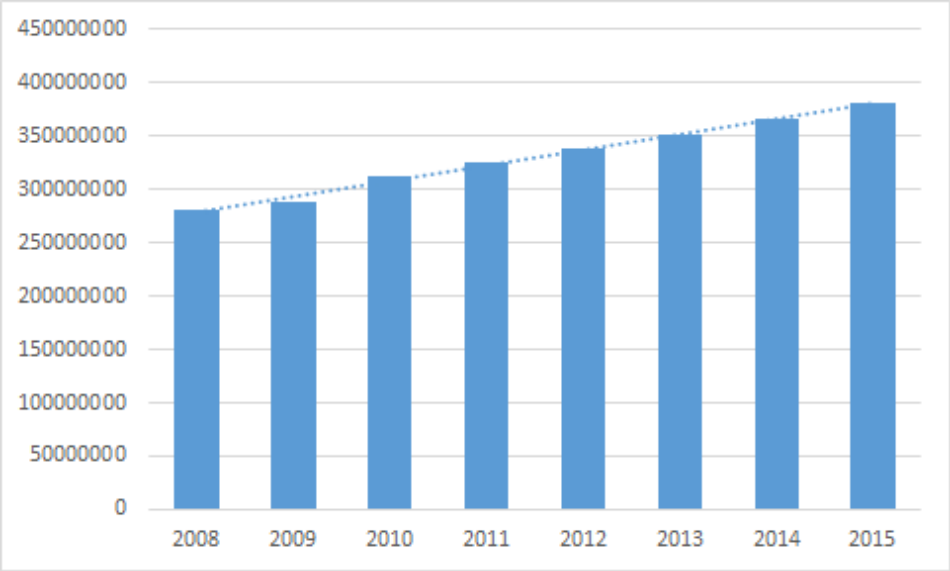
3.1 Determination of data

In this paper, the availability data of waste sources and treatment resources around the world are used to calculate, and the changes of guangdong province's EI index over time are also referred. (unit /ton)

Table2. Data

year	EI	production	landfill	inceneration	recycling	industral	agriculture	dailylife
2008	80.952	281000000	182088000	57886000	41026000	120830000	2810000	157360000
2009	77	288000000	182592000	61344000	44064000	129600000	14400000	144000000
2010	66.6	313000000	194060000	68860000	50080000	129895000	9703000	158378000
2011	63.142	325000000	196950000	73775000	54275000	132600000	4225000	195650000
2012	70.595	338000000	200096000	79092000	58812000	137566000	13520000	173732000
2013	71.611	352000000	203456000	84832000	63712000	137280000	17600000	197120000
2014	72.646	367000000	206988000	91016000	68996000	108632000	22020000	253230000
2015	72.825	381000000	209550000	97155000	74295000	105537000	21717000	251460000

Table3. Changes in world plastic production



3.2 Equation determination:

Based on this data, the regression coefficient of multiple linear regression equation can be obtained as follows:

Table4. Regression results

EI	Coef.	Std. Err.	t	P>t	Interval]
X_7	6.38E-07	8.34E-07	0.76	0.524	4.23E-06
X_5	-2.34E-06	2.30E-06	-1.02	0.416	7.57E-06
X_4	0	(omitted)			
X_6	0	(omitted)			
X_1	-1.17E-07	3.80E-07	-0.31	0.787	1.52E-06
X_3	5.20E-08	7.17E-07	0.07	0.949	3.14E-06
X_2	-4.59E-08	2.34E-07	-0.2	0.863	9.60E-07
_cons	344.735	198.7593	1.73	0.225	1199.927

The amount of incineration and the amount of recovery are deleted due to the multicollinearity, so as to reduce the error. Finally, the multiple linear regression equation of EI is obtained:

$$\mathrm{EI} = 344.735 - 1.17 \times 10^{-7} X_1 - 4.59 \times 10^{-8} X_2 + 5.20 \times 10^{-8} X_3 - 2.34 \times 10^{-6} X_5 + 5.20 \times 10^{-7} X_7$$

F=1.02， accept H_1， There is a regression relationship between independent variables and dependent variables.

Evaluation of regression equation:$R^2 = 0.7182$, the fitting degree is good

3.3 Solution

According to the environmental level specification, under the condition of no further damage to the environment, the environmental level is poor, EI≥20, and the EI threshold value of 20 is substituted into the equation to obtain the maximum amount of disposable plastic waste under this condition:4.3355963×10^9t

4. Conclusion

Based on the multiple regression analysis, this paper establish the equation of environment condition index and two influence factors: disposable plastic waste source and treatment method. According to EI index, the maximum amount of disposable plastic waste without further damage to the

environment is obtained. In order to protect the environment, a reference is given for the output adjustment of the current plastic industry.

References

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