ISSN 2522-6398 Vol. 3, Issue 8: 1-5, DOI: 10.25236/FER.2020.030801

Prediction of white pollution problem based on Logistic model

Yuting Wang [1,*], Xinxin Li [1], Tianjiao Li [2]

1 College of Hydraulic and Environmental Engineering, Three Gorges University, Yichang Hubei 443002, China
2 College of Electrical Engineering & New Energy, Three Gorges University, Yichang Hubei 443002, China
**Corresponding Author: E-mail: 447109140@qq.com*

ABSTRACT. *In order to get the environmental carrying capacity,a logistic function model of waste accumulation and time was established in this paper. In order to optimize the model, other influencing factors were further considered. Finally, combining a set of parameters which have already been known, we get a maximum plastic product waste that the environment can tolerate. Then this paper established the DPSIR model as a react to analyzing at what level can plastic waste be decreased so as to reach environmental safety. The results show that after the implementation of some measures to restrict plastics, China's environment has improved significantly, with white pollution dropping by 33.3%, stimulating the rise of the domestic waste recycling industry and the steady growth of the entire domestic economy.*

KEYWORDS: *logistic model, dpsir model, analogical analys*

1. Introduction

Nowadays, plastic products have entered in people's life everywhere. While the convenience brought by plastic products is being enjoyed by human beings, little do they know that the original blue planet is being invaded by white step by step. Therefore, it is necessary to study and solve problems related to plastic waste in this urgent stage of global control of white pollution.

2. Establishment and Solution of Logistic Growth Model

2.1 Model Establishment

With the passage of time, it is undeniable that the accumulated amount of disposable plastic product waste is always growing rapidly in a certain period of time. However, with the limitation of various factors such as the manufacture of plastic raw materials and the available environmental resources of accumulated waste, this paper considers that the growth rate of disposable plastic product waste is gradually decreasing, and establishes the logistic block growth model to further solve the problem The maximum level of material product waste accumulation to ensure that the environment will not be further broken.

First of all, if no restrictions are considered, such as the available environmental resources of accumulated waste, the accumulated amount of plastic product waste is as follows:

$$\frac{dW(t)}{dt} = rW(t) \tag{1}$$

However, due to the limitations of the above factors, the right side of equation (1) should include the retardation factor of the maximum accumulated amount of plastic product waste $\left(1 - W(t)/W_{\max}\right)$. Equation (1) can be amended as follows:

$$\frac{\mathrm{d}W(t)}{\mathrm{d}t} = rW(t)\left(1 - \frac{W(t)}{W_{\max}}\right) \tag{2}$$

In this paper, the influence of vegetation coverage T, population density Y and industrial development level Z on the growth of plastic product waste is considered. Generally, the greater the vegetation coverage in a region,

ISSN 2522-6398 Vol. 3, Issue 8: 1-5, DOI: 10.25236/FER.2020.030801

the less the plastic waste is. On the contrary, the greater the population density and industrial anti war level, the more disposable plastic waste will be produced.The inherent retardation factors of these three factors αT , βY , λZ to the growth of waste accumulation of plastic products can be modified as $\left(1-W(t)/W_{\max}-\sigma T-\beta Y-\lambda Z\right)$ .Equation (2) can be corrected as:

$$\frac{\mathrm{d}W(t)}{\mathrm{d}t}=rW(t)\left(1-\frac{W(t)}{W_{\max}}-\sigma T-\beta Y-\lambda Z\right)$$

Make $\sigma=1-\alpha T-\beta T-\gamma T$ .The function of waste accumulation and time $W(t)$ is:

$$W(t)=15\cdot\sigma\cdot W_{\max}\cdot\frac{\mathrm{e}^{\sigma rt}}{\sigma W_{\max}+15\left(\mathrm{e}^{\sigma rt}-1\right)}$$

2.2 Solution and test of the model

The parameters of the model are set by MATLAB program, and the quantity of plastic waste in 50 years is simulated, and the optimized logistic function model is obtained:

As can be seen from MATLAB program, the maximum capacity of plastic product waste without further impact on the environment is 140 million tons. The chi square test with SPSS shows that F = 52.754, and the fitting degree meets the requirements.

3. Establishment of Model Based on Entropy Weight Topsis Method

3.1 Range Normalization Process Data

Original evaluation matrix of environmental safety levels set as follows:

$$P=\begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1n} \\ p_{21} & p_{22} & \cdots & p_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ p_{m1} & p_{m2} & \cdots & p_{mn} \end{bmatrix}$$

In the formula, Pmn is the m-th index and the original value of the n-th year.

Since the data of different indicators have different unit dimensions, this paper needs to perform dimensionless processing on the original data. In order to obtain a standardized matrix with a uniform dimension. Meanwhile, according to the type of indicators it can be divided into two types, were treated as follows:

For promotion level indicators:

$$q_{ij}=(p_{mn}-p_{n\min})/(p_{n\max}-p_{n\min}) \tag{3}$$

For indicators of suppression levels:

$$q_{ij}=\left(p_{nmax}-p_{mn}\right)/\left(p_{nmax}-p_{nmin}\right) \tag{4}$$

So get the normalized matrix:

$$Q=\begin{bmatrix} q_{11} & q_{12} & \cdots & q_{1j} \\ q_{21} & q_{22} & \cdots & q_{2j} \\ \vdots & \vdots & \vdots & \vdots \\ q_{i1} & q_{i2} & \cdots & q_{ij} \end{bmatrix}$$

In the formula, qij is the standard value of the n-th index of the m-th index.

ISSN 2522-6398 Vol. 3, Issue 8: 1-5, DOI: 10.25236/FER.2020.030801

3.2 Entropy Weight Method to Determine Index Weight

Entropy is a very ideal scale in many indicators and evaluations. This paper uses the entropy weight method to take into account the multi-level and multi-targeting of indicators to reduce human interference. The entropy calculation formula is derived as follows:

The characteristic proportions of various evaluation indicators are:

$$l_{ij} = \frac{q_{ij}}{\sum_{j=1}^{n} q_{ij}}$$

Information entropy is

$$T_i = -\frac{1}{\ln n}\sum_{j=1}^{n} l_{ij} \ln l_{ij}$$

In the formula,, make ln0=0.

From the above available entropy weight formula is

$$w_i = \frac{1 - T_i}{m - \sum_{i=1}^{m} T_i}$$

This article examines global levels of environmental safety, collect and organize data through multiple channels. After standardizing the calculations by formulas (3) and (4), the entropy weight method is used to determine the weight of each evaluation index.

3.3 Establishment of Environmental Safety Level Evaluation Matrix Based on Entropy Weight

With the help of weighting ideas, a weighted linear operation is performed on the standardized data to construct a weighted normalized evaluation matrix as follows.

$$S = \begin{bmatrix} s_{11} & s_{12} & \cdots & s_{1n} \\ s_{21} & s_{22} & \cdots & s_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ s_{m1} & s_{m2} & \cdots & s_{mn} \end{bmatrix} = \begin{bmatrix} q_{11} \cdot w_1 & q_{12} \cdot w_1 & \cdots & q_{1n} \cdot w_1 \\ q_{21} \cdot w_2 & q_{22} \cdot w_2 & \cdots & q_{2n} \cdot w_2 \\ \vdots & \vdots & \vdots & \vdots \\ q_{m1} \cdot w_m & q_{m2} \cdot w_m & \cdots & q_{mn} \cdot w_m \end{bmatrix}$$

3.4 To determine the positive and negative ideal solution

Just ideal is the most preferred solution, That is the maximum value of the i-th index in the evaluation data in j-year, The formula is as follows:

$S^+ = \left\{\max_{1 \le i \le m} s_{ij} \mid i = 1, 2, \cdots, m\right\} = \left\{s_1^+, s_2^+, \cdots, s_m^+\right\}$ Negative ideal is the least preferred solution, That is the minimum value of the i-th index in the evaluation data in j-year, The formula is as follows:

$S^- = \left\{\min_{1 \leqslant i \leqslant m} s_{ij} \mid i = 1, 2, \cdots, m\right\} = \left\{s_1^-, s_2^-, \cdots, s_m^-\right\}$ 3.5 Calculate Euclidean distance

This article uses the Euclidean distance to calculate the weighted distance between the index and the ideal target. Let S_j^+ , S_j^- be the distance between S_i^+ and S_i^- , The expression is as follows:

ISSN 2522-6398 Vol. 3, Issue 8: 1-5, DOI: 10.25236/FER.2020.030801

$$D_j^+ = \sqrt{\sum_{i=1}^{m}\left(S_i^+ - S_{ij}\right)^2}$$

$$D_j^- = \sqrt{\sum_{i=1}^{m}\left(S_i^- - S_{ij}\right)^2}$$

3.5 Calculate the Closeness between the Evaluation Object and the Ideal Solution

Calculated as follows:

$$T_j = \frac{S_j^-}{S_j^- + S_j^+}$$

Where Tj is the environmental safety level in the j-th year approaching the maximum carrying capacity. For the research in this article, that is, the degree of maximum accumulation of disposable plastic product waste, called closeness, the value ranges from 0 to 1. When Tj=1, The environmental safety level is the maximum carrying capacity of the environment. At this time, the waste has the largest cumulative amount. When the corresponding Tj = 0, the environmental safety level is the lowest.

3.6 Calculate the Amount of Waste to Achieve Environmental Safety

According to the actual ecological situation and related literature research, it is shown that the closeness of the global environmental security level can be divided into the following five stages, which correspond to the five environmental security levels.

In the same way, the above analysis of the quantity of plastic waste, the change trend with the environmental safety level is obtained as follows:

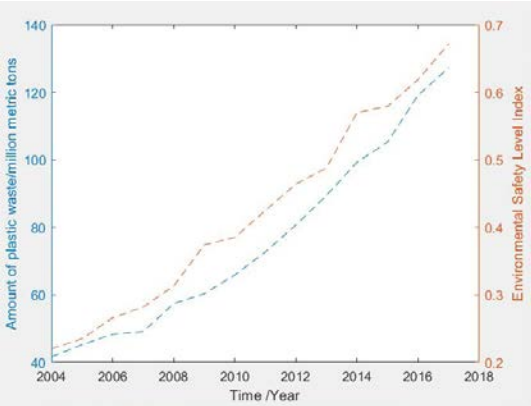

Fig.1 7.2 Evaluation Curve under the Entropy Weight Topsis Method

Therefore, this article is simplified. According to the first question, the cumulative amount of disposable plastic product waste that does not cause further environmental damage is 140 million tons. According to Fig. 3.7.2 the corresponding relationship between the amount of waste and the closeness of 140 million tons corresponds to T=0.2 in the table above, and T=0.3 when the environmental safety level is reached.

$$w = 140 \times \frac{0.2}{0.3} = 93.33(\mathit{Million\ tons})$$

4. Conclusion

In this paper, a logistic function model of waste accumulation and time was established to get the

ISSN 2522-6398 Vol. 3, Issue 8: 1-5, DOI: 10.25236/FER.2020.030801

environmental carrying capacity. Three factors including vegetation coverage rate, population density and industrial development level were representatively selected to obtain the function of waste accumulation over time. The model is used to predict the data of the non-implementation of the ban on imported solid waste and compare it with the data after the actual implementation. The results show that after the implementation of the ban, the degree of environmental pollution has been significantly reduced. Economically, the “imported waste ban” has dealt a blow to the development of imported waste treatment enterprises, and to a certain extent stimulated the growth of the domestic “waste recycling industry” and surrounding industries.

References

[1] Yanping Wang, Yixiang Deng, Chenglong Zhang, et al (2020). Research on China's disposable plastic pollution management countermeasures [J/ OL] .Environmental Science Research, pp.1-11.
[2] Chen Huang (2019). Forecasting Analysis of China's Future Population Based on Logistic Model [J]. China New Telecommunications, vol.21, no.23, pp.160-161.
[3] Guirong Xiao, Yanjun Zhao, Lingling Guo (2016). Evaluation and Demonstration of Urban Green Transformation Based on DPSIR-TOPSIS: Taking Taiyuan City as an Example [J]. Technology Economy, vol.35, no.12, pp.82-89.