Problem Chosen	2020	Team Control Number
E	MCM/ICM Summary Sheet	**2012082**

Estimation of Global Plastic Waste Level

Summary

Plastic is an important and ubiquitous material widely used in the whole world. But there are also lots of problems in managing single-use or disposable plastic product waste globally. For example, plastic products do not readily break down, are difficult to dispose of, and only about 9 pencent of plastics are recycled. As current trend, if we continue using it without control, our oceans around the world will possibly be filled with plastic waste in 2050. Therefore, we have to find effective methods to solve this dilemma.

To begin with, we establish a model to predict the maximum level of single-use or disposable plastic product waste. We make an assumption that due to the data given by ICM, by 2050 our ocean will be flooded by plastic, so the maximum value we are looking for is in 2050. Because relevant factors in this problem are complex, and some index cannot be estimated quantitatively, we finally select Grey Forecast Model (GFM) to make prediction. After searching for data on internet, we decide 2 mainly relevant indicators used in GM (1, n).

Then, considering that plastic usage and countries' ability differ widely among countries, we build a new model called ESL (Environmentally Safe Level) to evaluate each country's situation. We mainly use the Analytic Hierarchy Process (AHP) to build this model and calculate their weights. Through carefully analyzing on the data we found, we use several kinds of data to extract 3 indexes in Theme Layer, which contains 7 indicators in Indicator Layer. After calculating weight of each indicator, we obtain a new equation to access every country from different aspects. Then we take USA, China, Finland and India for examples to verify our model. It turns out that our ESL model is corresponding with actual state.

Next, we try to figure out the minimal achievable level of global waste of single-use or disposable plastic products. From task 1, we get an expression about global plastic production. Then we utilize data about globally recycling ability and find another equation. Using these two equations, we can estimate an intersection time point and the accumulated plastic waste is our result for this problem.

There is no doubt that we have to solve this problem before it causes irreparable damage to our world. So we divided these countries into different categories according to our model's score, and make some intended suggestions for each kind of countries aimed at their unique problems and corresponding plans.

Finally, we analyze the sensitivity of the model, by changing a parameter of ESL and we evaluate the model and give some suggestions for improvement.

Keywords: global plastic waste; environmentally safe; ESL model; AHP; GM(1,n).

Contents

1 Introduction

1.1 Restatement of the Problem

The various use of the plastic products benefits people's daily lives a lot. While the negative impacts associated with increasing plastic products are concerning. In that it's difficult to dispose the plastic waste properly, it has resulted in severe environmental problems.

In this paper, we are aimed to address the escalating environmental crisis and propose a plan to reduce the plastic waste in these ways:

- Creating a model to estimate the maximum levels of plastic waste without further environmental damage.
- Estimating the minimum level of plastic waste and discussing its impact.
- Giving suggestions on taking measures in different degree to regions in different situations.
- Predicting the timeline to reach the minimum level of the plastic product waste.

1.2 Problem Analysis

The maximum level of the plastic product waste is limited by environmental health. So, we bring in indexs to estimate environmental health in analytical hierarchy process and find out the relation between plastic product waste and the environment index in analysis of regression. And the minimum level is defined by the need of economic and social progress, which varies from country to country. Therefore, we bring in an evaluation system in two dimensions to digitalize each country's ability and duty. Accordingly, we formulate different sets of strategy for countries in different level. In the suggested cases, considering factors such as policies, people's need, availability of alternatives and so on, we predict the timeline in time series.

1.3 Our Work

In order to solve the severe plastic waste problem in the world, we establish a Grey Forecast Model. Considering some relevant factors, we make statistics and estimates on the issue of the single-use or disposable plastic product waste. Then we establish an environmental safety assessment model as the main model. By selecting the appropriate evaluation indicators, we assign target weights and combine these indicators to achieve comprehensive indicators. Then we apply the model and propose modification plans to improve it.

Firstly, we create a Grey Forcast Model. According to comprehensive consideration of the factors: source of waste, the severity of the current waste problem, and the availability of waste resources, we obtain a calculation formula to estimate the maximum waste of disposable plastic products. Combined with data on the amount of the worldwide recycled plastic waste, the derived formulas are used to predict the lowest level of disposable or disposable plastic waste in the world. We also discuss the measures about how to reach this level.

Secondly, the assessment model we build will estimate the environmental safety level according to the region. In this model, we design a scoring mechanism for environmental safety. In the mechanism, the principal component analysis method is used to determine the weight of seven elements (such as plastic waste, policy and expenditure etc.) in three categories (such as factories, countries, and individuals). Higher score means higher level of environmental safety in a region. Then the model is verified by national data of China and the United States and proved to be reasonable. The model is also used to obtain the minimum waste target and analyze its impact.

Finally, by referring to the above models and comprehensively considering economic, policies and other factors, we calculate and draw an image of the global change in the amount of plastic waste over time, and predict the time when the single-use or disposable plastic waste reach the minimum level.

2 General Assumption

- **The countries or regions we studied are regular and stable in all aspects.**
  There are no major natural disasters in the following years. And there are no big changes in economy and society in the following years.
- **The datasets we used can fully express corresponding indicators.**
  There are quantities of factors affecting a indicator. To simplify the model, we only take some crucial factors into consideration. So, we assume that other factors have few influences on the model.
- **The datasets are of high confidence level.**

3 Notations Description

Notations	Description
ESL	environmental safety level
ESS	environmental safety score
$PWPC$	plastic waste per capita
NPP	national plastic production
IL	industrialization level
GDP	Gross National Product
C	cause
R	rresponsibility
r_i	the i-th indicator
H_i	the i-th indicator of human
I_j	the j-th indicator of industry
C_k	the k-th indicator of country

4 Model Design

4.1 Find the Maximum Level

Plastic is a kind of significant and ubiquitous material in economy and our daily lives. However, it does not readily break down, and is difficult to dispose of. If we do not control the speed of plastic usage around the world, the accumulated single-use and disposable plastic product waste in 2050 will fill our oceans. So, we have to find the maximum level of plastic waste without irreparable harm to the environment.

Considering several factors related to the prediction of the level of total waste, which contains the source of waste, the severity of the current waste problem and methods of managing waste problem and etc. The relationship between them is complex and difficult to quantify. Because there are both known and unknown information in this problem, we decided to use the **Grey Forecast Model (GFM)** to predict.

4.1.1 Assumptions and Factors

In order to solve this problem, we propose the following assumptions for our forecasting convenience:

- It is considered that the factors we choose are the main indicators affecting the results, and other factors have little influence on the results, which can be ignored.
- These two factors will basically maintain the current trend. And we exclude the possibility of important changes in these factors (for example, the world suddenly finds a substitute for plastic which totally replaces all plastic material).
- Due to the data given by ICM, by 2050 our ocean will be flooded by plastic, so the maximum value we are looking for is in 2050.

After searching data and analyzing, our group think that there are two important factors for prediction:

- **Severity of waste problem**: we use the total amount of plastic waste in the world to express severity of the problem, which is directly related to the maximum level of plastic waste that we want to predict.

- **Methods of solving waste**: there are basically three ways to process plastic waste: discarded, incinerated and recycled. The effect of these three ways is different. The biggest harm to the environment is discarded which often winds up in dumping into the ocean.

There are two typical models in the Grey Forecast Model i.e. GM (1,1) and GM (1, n), which respectively means establishing first order differential equation in one variable or multiple variables. Because we consider two factors here, we choose model GM (1, n) for prediction.

4.1.2 Grey Forecast Model

The independent variable matrix is composed of severity of waste problem (SWP) and methods of solving waste (MSW). First, implement Accumulated Generating Operator to establish accumulated sequence of these two factors:

$$X_i^{(1)}(k) = \sum_{k=1}^{n} x_i^{(0)}(k), (i = 1, 2, ...n) \tag{1}$$

Where: x_1 is data of SWP, x_2 is data of MSW.

Then calculating mean generation with consecutive neighbor:

$$Z_1^{(1)}(k) = \frac{1}{2}[X_i^{(1)}(k) - X_i^{(1)}(k-1)], k = 2, 3, ...n \tag{2}$$

After selecting the coefficient α, the GM(1,n) model can be obtained by adding the above two sequences:

$$x_i^{(0)}(k) + aZ_1^{(1)}(k) = \sum_{i=2}^{N} b_i x_1^{(1)}(k) \tag{3}$$

Running the program in MATLAB, we can get the predicted results in 2050. It can be seen from the following figure that the predicted value and the actual value fits great:

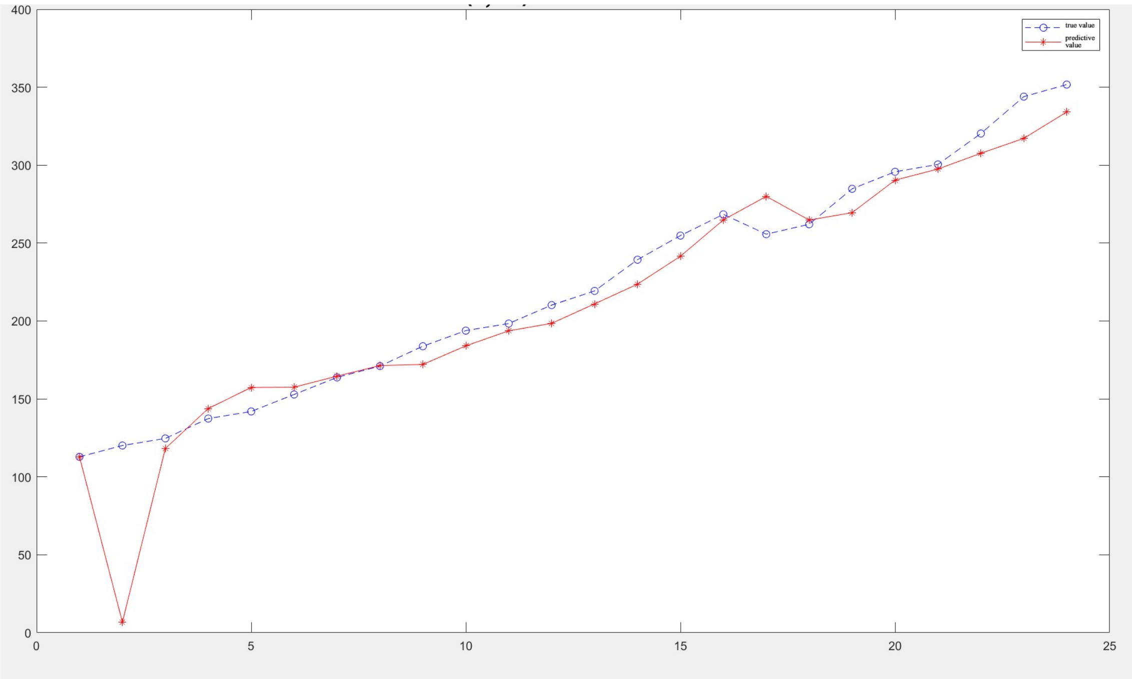

Figure 1: GM(1,n) forcast result

The forecast SWP, MSW and single-use and disposable plastic product waste in 2050 are shown in the table below:

Factors	2050
SWP	346.5
MSW	47.8
Total Plastic Waste	32550

After the residual analysis, the Posterior difference ratio P = 0.974 > 0.95, Variance of residuals C = 0.289 < 0.35. According to this, the prediction is of high accuracy. So, for Task 1 we set 32550[million tons] single-use and disposable plastic product waste as the largest level of global plastic waste.

4.2 ESL Model

4.2.1 Identify Indicators

In order to discuss to what extent, we want to reduce the plastic waste, we set up a model called ESL (Environmental Safety Level) to evaluate a country's comprehensive management capacity to achieve a good environmentally safe level. And we use the result of ESL– ESS(Environmental Safety Score) to judge a country's ability specifically.

After careful analysis and research, we found a database and extracted the following indicators to build this model.

Target Layer	Theme Layer	Indicator Layer	
Environmentally Safe Level	Human	Plastic waste per capita	-
		People's happiness index	+
	Industry	Source and use of plastic waste	-
		Disposable plastics	+
		Processing method of plastic waste	-
	Country	National policies	+
		Environmental protection expenditure	+

Figure 2: Indicators in AHP

Because the relationship between these indicators is complex and some are difficult to fully quantitative analysis, we use Analytic Hierarchy Process (AHP) and Experts Grading Method(EGM) to calculate the weight of indicators.

1 Human

- **Plastic waste per capita**: it describes the plastic waste per person in various countries in the world. The lower the index is, the higher quality of the people is, and the higher the ESS is.

- **People's happiness index**: as an index to describe the quality of people's life, it reflects the country's ability to eliminate waste and show environmental safety level. The higher the indicator, the higher the ESS is.

2 Industry

- **Source and use of plastic waste**: we divided it into construction, agriculture and other. And they impact environmental safety differently. After consulting data from internet, we set the weight of 0.4, 0.3 and 0.3 for construction, agriculture and other. The lower the index, the higher the ESS is.

- **Disposable plastics**: after searching data on the Internet, we choose the recovery rate of PET as a figure to reflect this index. Because PET is a new type plastic which can be recycled and reuse and it's now the main substitute of single-use or disposable plastics. The higher the index, the higher the ESS is.

- **Processing method of plastic waste**: the main three methods are discarded, incorporated and recycled. It has been estimated that 55 percent of global plastic waste was discarded, 25 percent was incorporated and 20 percent recycled. The impact of each on environmentally safe is also different. After analyzing the data, we find that discarded plastic is not easy to decompose and may become micro-plastic merging into the land. So, we set a weight of 0.5 for discarded, 0.3 for incorporated, and 0.1 for recycled. The lower the index, the higher the ESS is.

3 Country

- **National policies**: analyzes the policies on plastics issued in those country. To a certain extent, the national policies have promoted the development of the state's ability to deal with plastic waste. According to the number and content of the policies, we give each nation a score. The higher the index, the higher the ESS is.

- **Environmental protection expenditure**: reflects the state's attitude towards pollution treatment and environmental safety. The higher the index, the higher the ESS is.

4.2.2 Data Normalization

We visited the World Bank, WRI, UNESCO, Plastics Europe to find data, including 7 indicators in 20 countries. Some statistics of indicators are missing for not all statistics can be searched on the Internet. As mentioned above, our indicators are mainly divided into two types. Symbol '+' means for this indicator that bigger is better. Symbol '-' means the opposite. So, we use two different methods to normalize those data.

For '+' type's indicators, the equation for normalization should be:

$$r_i = \frac{r_i - r_{min}}{r_{max} - r_{min}} \tag{4}$$

Where: r_{max} is the maximum value of this group of indicators, r_{min} is the minimum value of this group of indicators.

for '-' type's indicators, the equation for normalization should be:

$$r_i = \frac{r_{max} - r_i}{r_{max} - r_{min}} \tag{5}$$

4.2.3 Calculate Weight by AHP

We use AHP to calculate the weights of indicators in ESL model.

First, we define the expression:

$$ESS = k_1 H + k_2 I + k_3 C \tag{6}$$

Where: H is human, I is industry, C is country

$$\begin{aligned} H &= \sum_{1}^{n} \alpha_i H_i \\ I &= \sum_{1}^{n} \beta_j I_j \\ C &= \sum_{1}^{n} \gamma_k C_k \end{aligned} \tag{7}$$

Where: $\alpha_i, \beta_j, \gamma_k$ are the corresponding weights in the indicator layer, n means the number of indicators and H_i representations the indicators of human, and the rest are the same.

Then we build a comparison matrix for the three elements of theme layer, and determine C_{ij} by the importance of H_i to I_j. Similarly, we construct the score matrices and calculate the weight of theme layer.

Because there are seven indicators in the third layer, it is difficult to calculate with AHP, so we use the Expert Grading Method (EGM) to calculate the weight of each indicator.

4.2.4 Test Our Model

After calculating the weight, we can get the specific expression of ESL. The expression is:

$$\begin{aligned} &ESS = 0.71H + 0.51I + 0.33C \\ &H = 0.05H_1 + 0.2H_2 \\ &I = 0.2I_1 + 0.13I_2 + 0.1I_3 \\ &C = 0.165C_1 + 0.165C_2 \end{aligned} \tag{8}$$

We find four representative countries: the United States, Finland, China and India, and bring those country's data into our model to calculate the ESL score and compare with the reality of each country. Then analyze the result to see if it matches our assumption – the higher the score, the stronger the country's ability to process pollution, i.e. the higher the environmental safety level. compared with the actual situation of each country.

After calculation, the scores of the four countries are as follows:

Factor / Country	People		Industry			Country	
	Plastic waste per capita	People's happiness index	Source and use of plastic waste	Disposable plastics	Processing method of plastic waste	National policies	Environmental protection expenditure
China	0.149	0.219	0.320	0.098	0.173	0.223	0.167
America	0.287	0.287	0.272	0.265	0.328	0.281	0.302
Finland	0.486	0.319	0.174	0.501	0.401	0.312	0.396
India	0.077	0.175	0.234	0.136	0.098	0.184	0.136

Figure 3: ESL's result in table

As shown above, the ESS of the United States is 0.575, 0.664 for Finland, 0.437 for China, 0.324 for India. This results are basically consistent with the actual data and situation on the Internet. In other words, United States, Finland and other European countries perform well in processing single-use or disposable plastic, and the share of global total mismanaged plastic waste is relatively small. Some Asian countries such as China and India don't do a good job in this aspect, and the their share of global total mismanaged plastic waste is almost 40 percent of the world.

The result proves that our model is basically correct. In order to determine the appropriate level of environmental safety level in task 2, we selected 12 countries to calculate their ESL scores and draw the following scatter diagram:

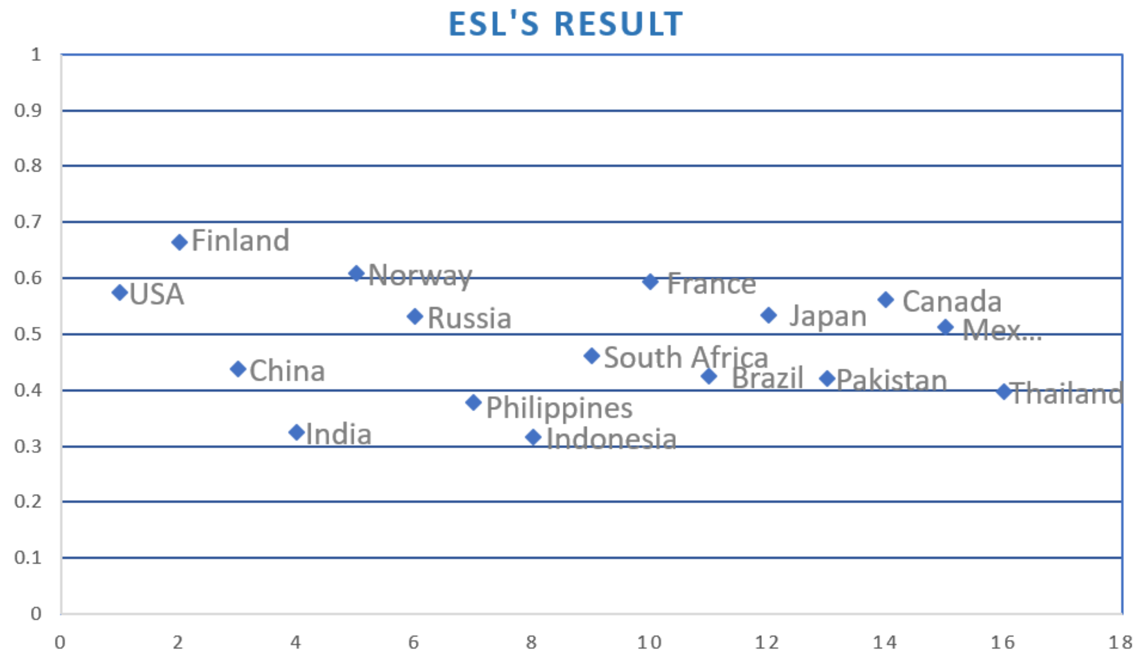

Figure 4: ESL's result in scatter diagram

We can see the results on the figure above, which makes comparison easily. Through the comparison of scatter diagram and the facts, we can define $ESS = 0.6$ as a boundary of good environmental safety level.

4.3 Minimum Level of Plastic Productions

To mitigate the contradiction between plastic use and environment safe, there are mainly two directions. For one thing, we can cut down on the output of the plastic products per year globally. For another, plastic recycling ability ought to be leveled up. From the plastic production prediction model, we get the information that the plastic output grows in a linear model.

4.3.1 Curve Prediction of Recycling Ability

We collected the data of annual recycled plastic waste from 1980 to 2015. By curve fitting, we can get the equation between recycled plastic waste and time:

$$y = 0.0768x^2 - 0.641x + 0.9361 \tag{9}$$

Where y means the weight of recycled waste, and x means the number of years since 1980.

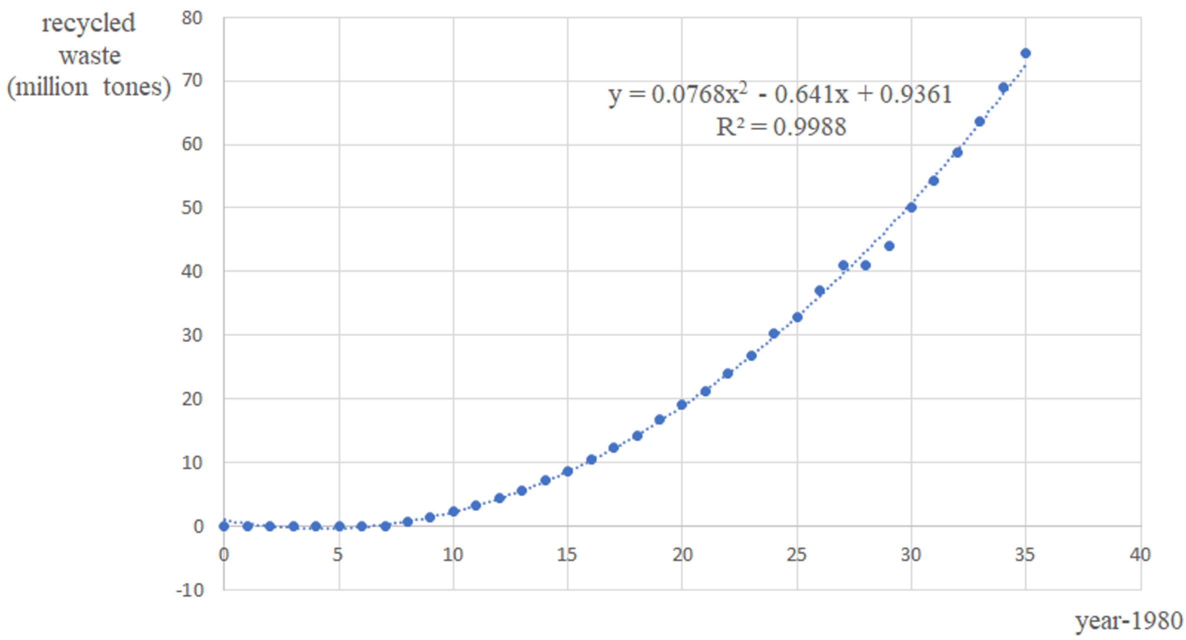

Figure 5: vairation trend of recycled waste

Using this equation, recycling ability can be predicted in the following years.

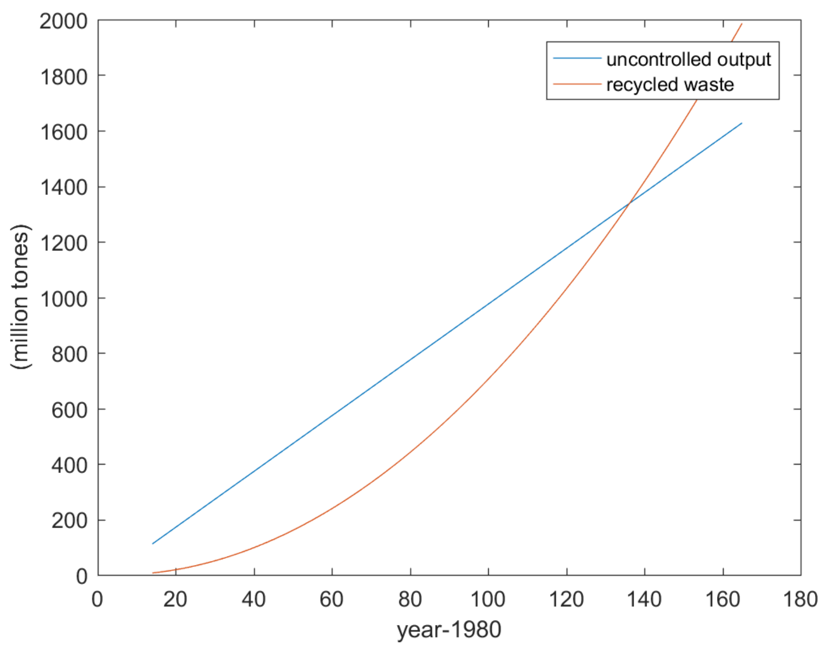

Figure 6: comparison between uncontrolled output and recycled waste

As we can see from the chart, without any measures taken on annual production, it will be nearly year 2120 that the quantity of plastic output and recycled waste can meet. In other words, people won't stop pulling plastic waste into the ocean and the soil until year 2120. However, before 2050, the earth is going to drown in the plastic waste.

4.3.2 Analysis on Curtailing Production

In order to meet the quantity of recycled waste as soon as possible, annual plastic output must be controlled. Plastic products enjoys a wide range of uses.

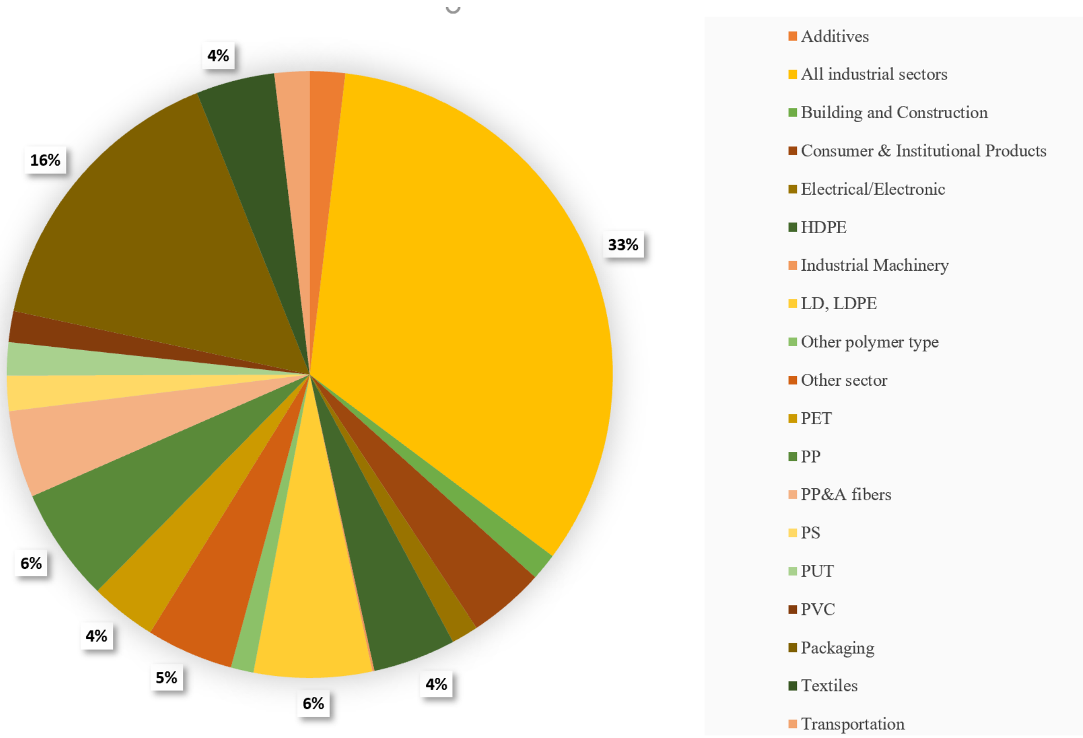

Figure 7: plastic waste by sectors

The flexibility of raw material varies from sectors to sectors. Take packaging for example, cloth can be a good substitute for plastic, which has less damage to the environment. Cutting down sectors with wide flexibility, we got an annual reduction of plastic products.

$$y = 7.905x - 284.58 \tag{10}$$

Where y means the reduction of plastic products, x means the number of years since 1980.

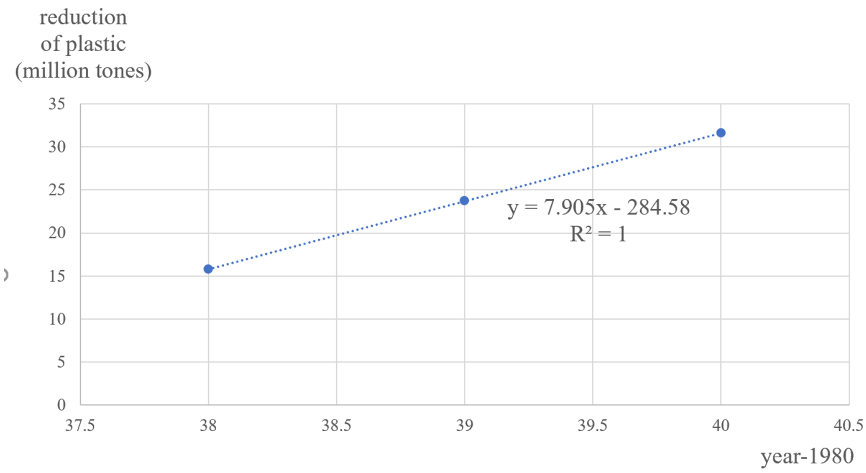

Figure 8: variation trend of reduced waste

Combining controlled production and recycled waste again.

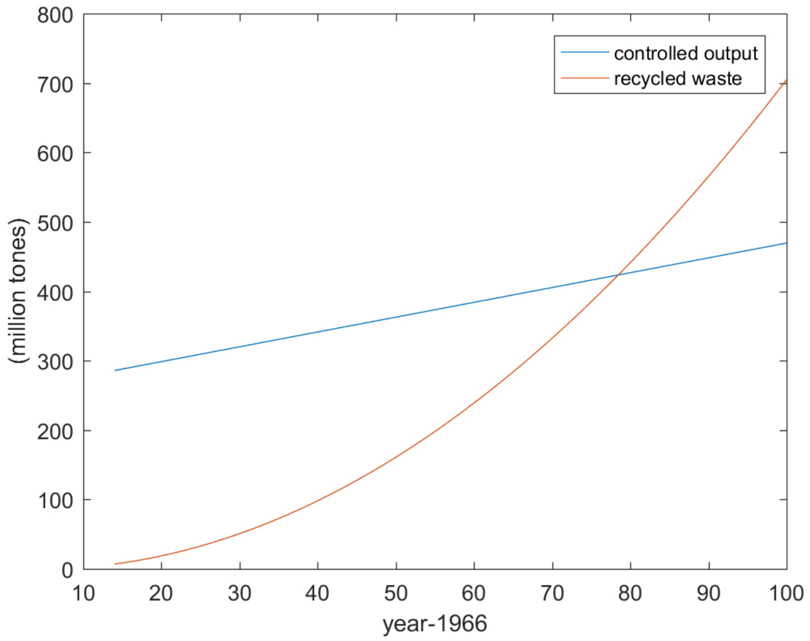

Figure 9: comparison between controlled output and recycled waste

As we can see from the chart above, the point of intersection happens in year 2044(74 years after year 1966). That is to say, under proper production control and waste management, we can get a minimal level of plastic waste. By year 2044, worldwide cumulative plastic waste will reach 3267.2267 million tones. After year 2044, we will be qualified for dealing with both annual plastic production and historical waste.

4.3.3 Impact on the Economy and the Environment

For most country, the plastics industry's production value accounts for a large proportion of GDP. So, cutting down on plastic production may hinder the economic progress to some extent. Plastic products are also one of major import and export cargo. The targeted minimal level will have negative influence on international trade. Besides, citizens' daily life will be altered. When we are shopping, it may be a little bit inconvenient without a free plastic bag. When plastic are charged, people will pay more attention to the plastic and environment issue. The figure below shows the impact on the environment.

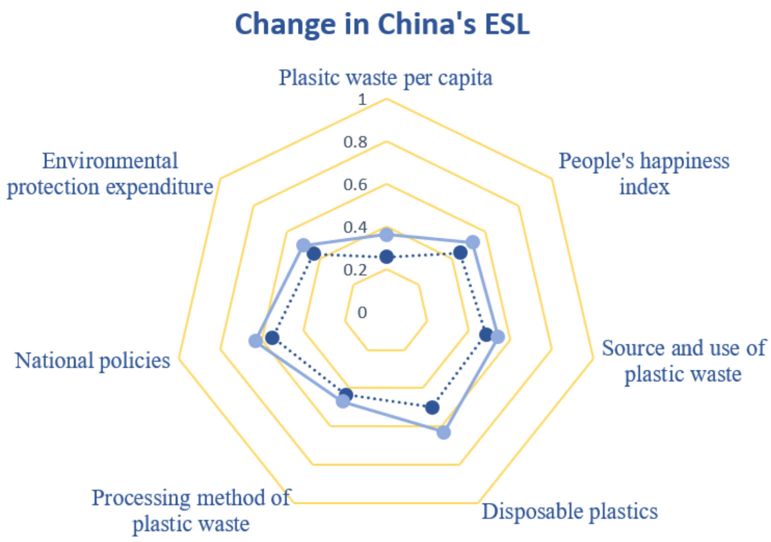

Figure 10: Changes in China's ESL

4.4 Solutions for Global Crisis

4.4.1 Selecting Indicators

It is a global task to reduce the single-use or disposable plastic waste. However, due to the different situation of each country, i.e. different economic development, different demand for plastic products and different management capacity for plastic waste, it is unreasonable to divide the task of plastic waste management equally in the global scope. Absolute fairness is a kind of unfairness. After our careful discussion and analysis, we select the following indicators as the basement for task allocation:

- **Plastic waste per capita (PWPC)**: we believe that this is a very important indicator to determine the amount of plastic waste that a country should be allocated. Because the population of different countries in the world differs widely, it is actually not fair for each country to deal with the same amount of plastic waste. So, we take an average factor into consideration. The average level of plastic waste in this country can be well reflected by per capita.

- **National plastic production (NPP)**: the best way to reduce plastic waste is to eliminate plastic production from the root. Therefore, a bigger plastic producer has more obligation to reduce the total plastic production and promote the global plastic production decline. These countries should consider improving the second utilization rate of plastics or developing new materials as plastic substitutes.

- **Gross National Product (GDP)**: it can directly reflect the economic level of a country. In response to this global environmental problem, we believe that countries with stronger capabilities have more responsibilities to solve this problem.

- **Industrialization level (IL)**: it reflects the industrial level of a country, and can be considered to reflect the production and manufacturing ability of a country. Similarly, we believe that the more productive countries may produce more plastic products. They also have more opportunities to develop new substitutes, and have great chance to solve this problem.

To sum up, we regard the two indicators, PWPC and NPP by a country as a category, "Cause".

It indicates that the more plastic this country produces and uses, the more part it should take to solve global plastic waste problem. The larger the indicator is, the more tasks it will undertake. Regarding the two indicators, GDP and IL as another category, "Responsibility". It shows that the country's economic and manufacturing capacity are relatively developed. So, on the global issue, they should take the lead in this issue. The larger the indicator is, the more tasks it will undertake.

4.4.2 Tasks Assignment

According to our discussion, the two factors in each index are of similar importance to them, so they are given a weight of 0.5 and 0.5. The equation is as follows:

$$\begin{aligned} C &= 0.5WPC + 0.5NPP \\ R &= 0.5GDP + 0.5IL \end{aligned} \tag{11}$$

Where: C is Cause, R is Responsibility.

We select 20 countries. After searching data, normalizing the data and calculating the results of each country, we turn the data into coordinate drawings and compare them with the facts for analysis.

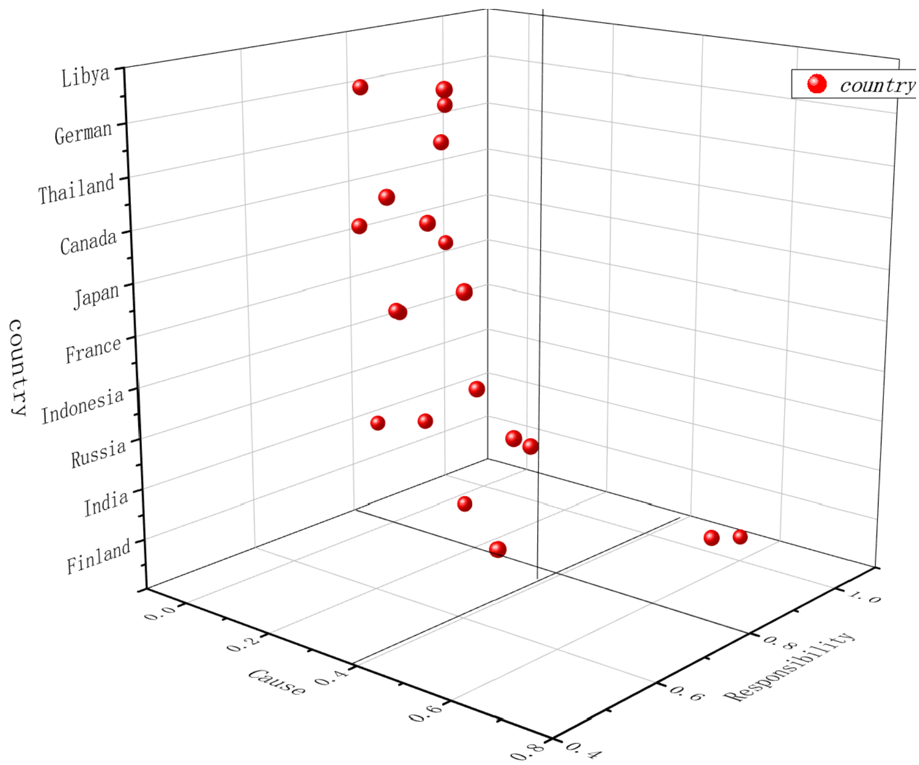

Figure 11: 20 countries' ability and responsibility

From the graph, we can see that these countries can be roughly divided into four categories in the coordinate graph:

- C is high and R is low: means the country like that utilize a great amount of plastic but the country is not wealthy enough. Our intended solution is a) to enact laws and regulations in the country to reduce the amount of plastic used by people and factories; b) to change the treatment of plastic waste by recycling instead of incineration and discarded.

- C is high and R is high: means the country cause plastic waste to a large extent while the country is wealthy enough. We suggest that a country like this should a) develop new scientific and technological products or find recycling solutions for plastics, and intensify the research and development of plastic substitutes; b) increase the environmental protection expenditure of the country; c) reduce the plastic import and export trade.

- C is low and R is low: means the country neither utilize much plastic nor get very rich. Our suggestion is to keep the status and not let the amount of plastic waste increase.

- C is low and R is high: means the country didn't use much plastic but it's rich. Our intended suggestion is a) keep the status and don't make plastic waste increase; b) strive to make progress in plastic manufacture and look for plastic substitutes.

5 A Memo to ICM

With the rapid development of science, technology and economy, the quantity of plastic products and their wastes increases exponentially. If we do not control the speed of plastic usage around the world, the accumulated single-use and disposable plastic product waste in 2050 will fill our oceans. Therefore, it's urgent to reduce the output of plastic products and manage plastic waste reasonably.

From a global perspective, our team selected some appropriate indicators, taking 2050 as a boundary, to predict the maximum level of global single-use or disposable plastic product waste through Grey Forcast Model. Because the level of environmental safety restricts the maximum level of plastic waste, we use Analytic Hierarchy Process to establish ESS model.

However, although the disposal of plastic waste is a global problem, the usage and manufacture of plastic in each country differs widely. So, we calculate the ESL scores of each country on the basis of verifying the ESL mode's correction, reflecting the environmental safety level of each country. According to the different usage of plastic and the different comprehensive strength of the country, we have assigned the task of reducing global single-use or disposable plastic product waste to different countries. In order to achieve the minimum achievable level of global plastics, we put forward the following suggestions:

- Enact laws and regulations in the country to reduce the amount of plastic used by people and factories.

- Change the treatment of plastic waste by recycling instead of incineration and discarded.

- Research and develop new scientific and technological products or find recycling solutions for plastics, and intensify the research and development of plastic substitutes.

In order to more clearly quantify the global minimum level of disposable plastic waste, we have done the following things. First of all, we get the equation of global plastic waste changing trend from the Task 1. Then, looking for data from the network, the equation of global recycled waste change trend is determined. Draw these two curves together and find their intersection. We find year 2044 is the year when the processing capacity and the total amount of global waste are balanced. And we also consider the impact of various policies to limit the use of plastic and change the way of people's daily life. Add the real data before 2020 to the forecast data by 2050 to get our final minimum level of global plastic waste. The timeline dynamic trend to reach this level is shown in the Figures below:

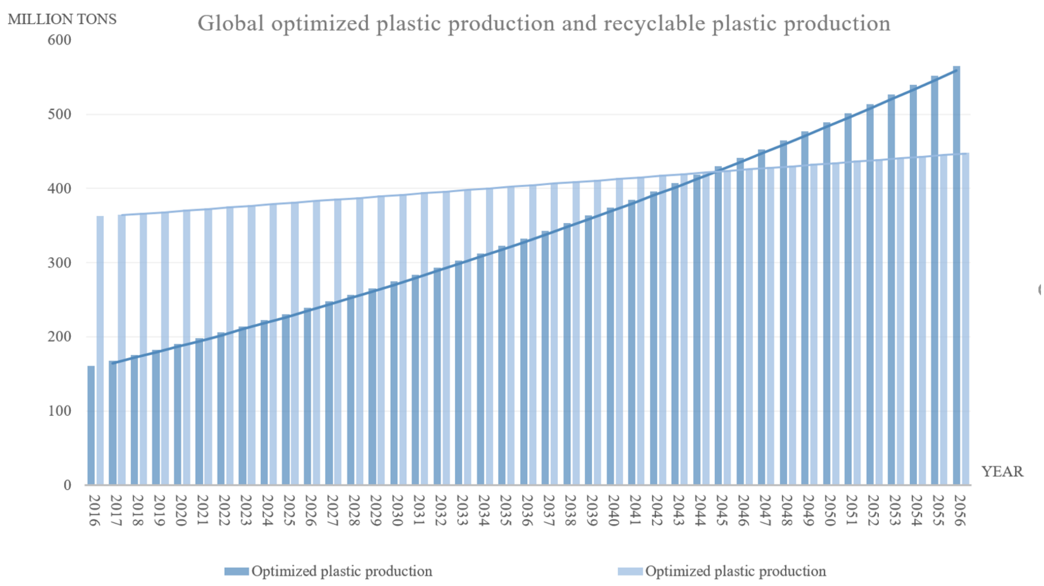

Figure 12: Global optimized plastic production and recyclable plastic production

Figure 13: Global plastic waste

We have listed several situations that may accelerate or hinder the achievement of the goals:

Acceleration:

- With the progress of science and technology, a great plastic substitutes have been developed.
- The secondary utilization rate of plastics has been greatly improved.

- Vigorously promote laws and regulations restricting the use of plastics around the world.

Obstacles:

- People's coordination is not high, and they can't reduce the plastic output in daily life.
- The recovery rate meets the bottleneck period, which is difficult to improve.
- The global population has further increased and no suitable plastic substitutes have been found. The total demand for plastic has further increased.

6 Sensitivity Analysis

In this section, we test the ESL model established in 3.2, and change the parameters of an index located in the indicator layer. Then analyze its sensitivity through the calculation results. We increase the coefficient β_1 by 30 percent, calculating the new ESS of each country. And make a scatter diagram to reflect the changing results intuitively:

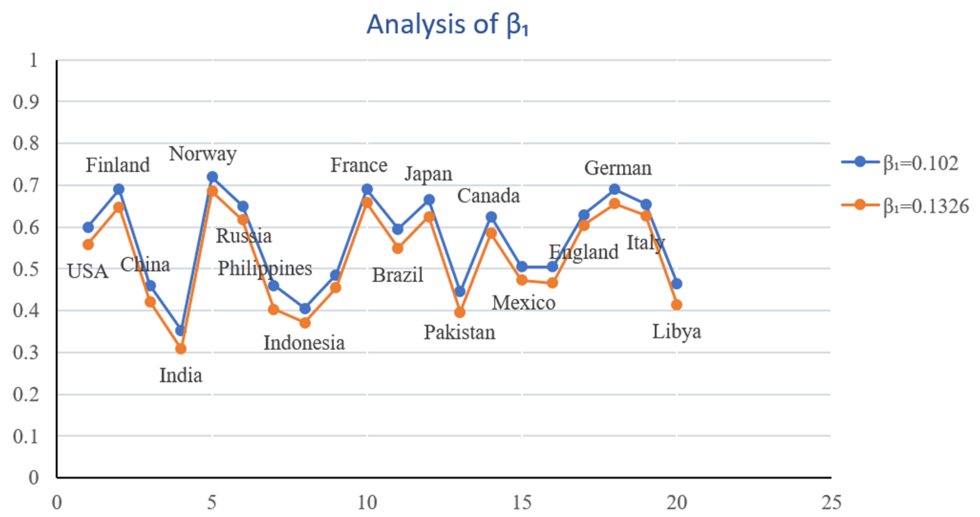

Figure 14: analysis of β_1

we can see that when the value of β_1 is changing, the final ESS's tend does not change a lot, which means that our model is basically stable.

7 Strengths and Weakness

Strengths

- The establishment of the model starts from the definition of environmental safety carrying capacity, and constitutes ESL. And The model uses comprehensive methods such as analytic hierarchy process. Based on rigorous mathematical derivation, the solution process is strict, the result is highly reliable, and the persuasive power is strong.
- We validate our model through some countries' data on plastic waste and find that our model is highly effective.

- Through the sensitivity test in the model validity analysis, the model has relatively high rationality and good generalization.

Weakness

- Due to the limitation of space and data, we obtain the accurate amount of plastic waste in various regions of the world.
- Part of the value is difficult to quantify and the accuracy is damaged during quantification.
- Disposable plastics and other factors is difficult to quantify, which will lead to bias in the final evaluation results.

References

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