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Preliminary Model and Exploration of Plastic Waste Governance

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Abstract **– This paper discusses the two country situations represented by the United Kingdom and Madagascar in the context of the environmental Kuznets curve through fundamental model construction and analysis, analyzes the positive and negative factors and makes recommendations accordingly. First, a survey on the governance and application of plastic waste around the world was conducted to analyse the current status of plastic waste governance. Second, the environmental Kuznets curve was used to model the emissions of domestic and single-use industrial waste, which led to the maximum amount of single-use plastic products. At the same time, given the imbalance in economic development and resource allocation, the countries of the world have been simplified into two categories: the economically developed countries, represented by the United Kingdom, and the relatively backward countries, represented by the Republic of Madagascar. The relationship between their level of environmental governance and economic development, resource allocation, etc., leads to factors that accelerate or hinder environmental protection. Finally, the search for effective ways to reduce plastic waste and impact factors from three aspects: the industrial level, the selection of alternatives, and national policies opens up new avenues for environmental protection.**

Keywords **– Plastic Waste, Environmental Kuznets Curve, Multiple Linear Regression Model, Weighted Average.**

I. INTRODUCTION

The creation of new materials also helped free people from the social and economic constraints imposed by the scarcity of natural resources. A Time magazine article noted that because of the war, “plastics have been turned to new uses and the adapt ability of plastics demonstrated all over again.” With the international community's attention to environmental protection and ecological sustainable development, environmental problems caused by materials and products are increasingly prominent. The use time of plastic products is far shorter than the time needed to relieve the pressure of plastic waste properly. It is predicted that, according to the current situation, by 2050, the plastic content in the ocean will far exceed that of fish. Large amounts of plastic can become entangled in marine life, leading to drowning, suffocation, death or being eaten by other creatures. This will eventually threaten human health as well [1].

In the early 1990s, the American economist Grousman etc. found, through an analysis of data from 42 countries, that the long-term relationship between total emissions of some environmental pollutants and economic growth also shows an inverted U-shaped curve, similar to the Kuznets curve, which reflects the relationship between economic growth and income distribution. There are already a number of scientists who are shifting their perspective to the governance and application of plastic waste. With regard to plastic products, their earliest mass production and use can be traced back to 1950 and was widely used outside the military after World War II. The ensuing rapid growth in plastic production has been extraordinary, outstripping most other man-made materials [2-3]. Amy L. noted that the rapid growth in the use and disposal of plastic materials is a challenge to solid waste management systems and has an impact on our environment [4]. Emphasizing the problem of marine pollution, Liu et al. pointed out that man's increasing ability to transform nature has seriously damaged the ecology of the oceans and seas, which has exceeded their carrying capacity [5]. Through the analysis of marine pollution, Zhou Yang etc. give a more rationalized opinion in terms of conceptual awareness, management system, etc. [6] Li, W. C. etc. provide detailed statistical information on regional data on plastic pollution, and state . Ocean gyres are particular hotspots of plastic waste accumulation. Both macroplastics and microplastics pose a risk to organisms in the natural environment. Many studies have investigated the potential uptake of hydrophobic contaminants, which can then bio accumulate in the food chain, from plastic waste by organisms. This leads to rationalization recommendations from the government and industrial chain [7].

II. General Environmental Modeling

For a region, the area of people's living area can be approximated as a circle centered on the place where people congregate, with R as the radius. Due to the influence of terrain distribution and human activities, the area is approximated as an outer circle with R as the radius according to the terrain distribution and the range of human activities. The contaminable area can be approximated as a closed cylinder with a depth of D and a radius of R. [8] the pollutants diffused from inside to outside of the model can be approximately converted into the self-purification capacity of the environment, while the pollutants permeated from outside to inside of the model can be converted into a part of the self-emission of the environment.

Disposable contaminants, which can be classified as disposable domestic waste and disposable industrial waste.

For example, in year n, for single-use domestic waste, the formula for emissions from domestic waste per capita,

$$F_n = K_n \times M_n \tag{1}$$

Where F_n is the nth year of one-time per capita domestic waste emissions. K_n is the emission factor for year n. M_n is per capita product use in year n.

In the case of disposable industrial waste, on the other hand, the higher the level of energy consumption, the more industrial waste.

$$S_n = Q_n \times C_n \tag{2}$$

Where S_n is the one-time industrial waste emissions in year n, Q_n is the industrial product use in year n and C_n is the emission factor in year n.

We can apply the environmental Kuznets curve, based on static assumptions of technological progress and environmental investment, where the per capita emissions of a single pollutant F_n are linearly related to the household economic level y. And its linear coefficient α itself is linearly related to the household economic level. Thus,

$$F_n = \beta_0\, y - \beta_1 y^2 \tag{3}$$

When a disposable pollutant is emitted at a rate that almost reaches the environment's own purification capacity, we can consider it to have reached its maximum emissions without damaging the environment.

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Assuming that the change in the stock of single-use pollutants over time can be represented by the differential equation,

$$A_t = \frac{dA}{dt} = F_t - \alpha A_t \tag{4}$$

Where, F_t and A_t are emissions and stocks of pollutants at t and α is the environmental cleanup factor.

To simplify the model, it is assumed that pollutant F is emitted continuously and uniformly from the beginning of the year to the end of the year; pollutant A is measured and calculated at the beginning of the year, and the average pollutant stock for the year is $\left(A + \frac{F}{2}\right)$: The pollutants that are decontaminated annually by the environment itself are $\alpha\left(A + \frac{F}{2}\right)$, $\alpha \in [0, 1]$.

When the total population is N_{TR}, the pollutant increments are,

$$\Delta A = -\alpha A + \beta_0\left(1 - \frac{\alpha}{2}\right)Y - \beta_1\left(1 - \frac{\alpha}{2}\right)\frac{Y^2}{N_{TR}} \tag{5}$$

Where $Y = yN_{TR} = GDP$

For formula (5) orders, $b_1 = -\alpha$, $b_2 = \beta_0\left(1 - \frac{\alpha}{2}\right)$, $b_3 = \beta_1\left(1 - \frac{\alpha}{2}\right)$; $x_1 = A$, $x_2 = Y$, $x_3 = \frac{Y^2}{N_{TR}}$; $Z = \Delta A$

The ternary linear equation is obtained.

$$Z = b_1x_1 + b_2x_2 + b_3x_3 \tag{6}$$

And then we get $\alpha = -b_1$, $\beta_0 = \frac{2b_2}{2+b_1}$, $\beta_1 = -\frac{2b_3}{2+b_1}$, the coordinates of the inflection point of the curve are $(\frac{\beta_0}{2\beta_1}, \frac{{\beta_0}^2}{4\beta_1})$.

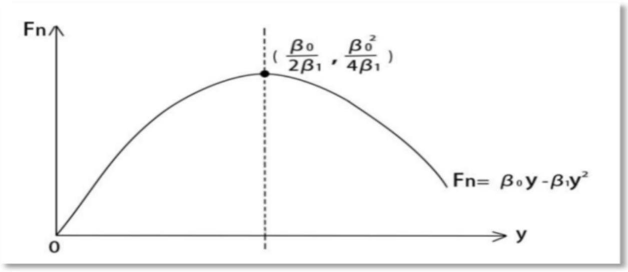

Fig. 1. Environmental Kuznets Curive.

Then the maximum amount is $W = F_n + S_n = \frac{{\beta_0}^2}{4\beta_1} + S_n$

Based on the above discussion, the model was constructed step by step and the pollutant storage in the region was calculated to be A_{area}. The pollutant density function $f_{area}\,(l, \theta, z)$, l has a value of $[r, R]$, θ has a value of $[0, 2\pi]$, z has a value of $[0, D]$.

So the stock is

$$A_{area} = \int_0^D \int_r^R \int_0^{2\pi} f_{area}\,(l, \theta, z) l d\,\theta dl dz \tag{7}$$

At this point we assume that the concentration of the contaminant in the region is only related to distance and not to depth.

The concentration of pollutants in the area is S_0.

Then point (l, θ, z) has a concentration of

$$f_s(l, \theta, z) = S_0 \frac{R-l}{R-r} \quad (8)$$

$$A = S_0 \frac{\pi D}{3(R-r)} (R^3 - 3Rr^2 + 2r^3) = S_0 \frac{\pi D}{3l} (R^3 - 3Rr^2 + 2r^3) \quad (9)$$

III. Country Situation Analysis

In the global economic development is not consistent, the uneven distribution of resources, we can within the global countries according to their economic situation for a simple division. In this paper, we will be roughly divided into the United Kingdom as the representative of the economically developed countries and the Republic of Madagascar as the representative of the relatively backward countries in two categories.

A. *Analysis of the British Situation*

As an important trading entity, economic power and financial center, the UK economy is the fifth largest in the world and one of the richest, most developed and highest living standards in the world. And Britain as an island, rich in marine resources, for the growth of marine litter has a certain impact. Therefore, the United Kingdom has a certain represent activeness.

In order to facilitate the model analysis, the following simplified assumptions can be made for the UK distribution. The central land area is 244,100 square kilometers. The equivalent radius r is 278.75 kilometers. Estimated contaminable area is 382,100 square kilometers. The equivalent radius R is 348.75 kilometers. The distance of the circular sea area is 70 km and the average water depth is about 3.7 km.

$$A = S_0 \frac{\pi D}{3l} (R^3 - 3Rr^2 + 2r^3) = S_0 \times 24.58 \times 10^{11} \quad (10)$$

Further calculations yield low concentrations of pollutants in areas around the UK where there is some experience in dealing with pollution.

B. *Analysis of the Republic of Madagascar*

Madagascar is one of the Least Developed Countries announced by the United Nations Conference on Trade and Development. According to the latest figures from the United Nations Development Programme, 70 per cent of Madagascar's population is living in poverty. And the Republic of Madagascar is an island country, close to the sea. Therefore, it has a certain represent activeness.

A similar approximation to that of the United Kingdom can be made to its central land area of 587,000 square kilometres. The equivalent radius r is 432.26 km. Estimated contaminable area is 740,000 square km, the equivalent radius R is 489.74 km, the distance of the annular sea area L is 57.48 km, the average water depth is about 3.9 km.

$$A = S_0 \frac{\pi D}{3l} (R^3 - 3Rr^2 + 2r^3) = S_0 \times 3.18 \times 10^8 \quad (11)$$

It was further concluded that the treatment of pollutants in the region around Madagascar is complex and needs to be further strengthened in the treatment of pollution.

Globally, countries differ in their geographical location, level of economic development, national policies, re-

-source allocation and so on. The perception and handling of single-use plastics varies from one country to another. By analyzing the economically developed countries, represented by the United Kingdom and the economically backward countries, represented by Madagascar, we can see that the economically developed countries have relatively high levels of pollution, but their capacity to deal with pollution is also relatively strong. Thus, economically lagging countries could work with economically developed countries to further learn from successful experiences in dealing with pollution. In the process of environmental transformation, we encounter both favorable conditions to advance our goals and unfavorable conditions to hinder us.

- As a result of our discussions, we believe that the following points will accelerate progress towards achieving the Goals.
- Increase public awareness. The media's role in guiding public opinion is indispensable for promoting environmental knowledge. In-depth promotion of environmental protection regulations, while improving the quality of residents, will also be conducive to the reduction of single-use plastic waste.
- To guide import and export trade. Appropriate import and export trade can contribute to the development of maritime transport and is also a catalyst for the marine environment.
- In addition to favourable conditions, there are also disadvantages in the implementation of policies and measures.
- The overall assessment was not strong enough. Due to institutional reasons, the management systems for ecological restoration and conservation in some countries are chronically scattered among different industry authorities, the top-level design, such as unified planning, is inadequate, and the basic systems and capacities, such as overall monitoring and assessment, are weak, which will undoubtedly hinder the achievement of global goals.
- Low level of technology. So far, no cleaning material has been invented in countries around the world that can replace plastic. Although countries have taken measures to reduce plastic pollution, such as plastic restriction orders, but the limited nature of technology makes it impossible to treat pollution from the source.
- The workload is high. Plastic pollution is a long-standing problem, and plastic waste is growing exponentially as it accumulates year after year. The overloaded workload makes the problem of plastic pollution a problem that cannot be solved overnight.

Fig. 2. Impact factors related to the goal.

IV. Related Recommendations

A. *Industrial Level*

In the dimension of industrial impact, we control the selection of raw materials and the recovery and disposal (Producer responsibility) of waste products.

1. *Selection of Raw Materials*

Sprite bottles have been green for 58 years, since Sprite drinks were first introduced in 1961. But Coca-Cola recently announced on its website that it would be making changes to the color of the bottles simply to increase the likelihood of recycling, without increasing the burden on dealers. Sprite will also increase the amount of recycled plastic in its bottles to 50% next year. Together, these initiatives will ensure that more than 23,000 tons of new plastic will no longer be used by businesses from 2020, and as can be seen from the above data, checking the level of raw material selection, step by step, will go a long way towards reducing pollution from plastic products.

2. *Producer Responsibility*

Producer responsibility is the management and control of products in the production process and even the whole life cycle, with special emphasis on the recovery and disposal of abandoned products. This aspect can not only be controlled from the material source to the production process and even the whole process of waste recycling. It can also provide reverse incentive to the produced sign of enterprises, and reduce unnecessary waste in the recycling process of plastic waste. It can be seen that the establishment of a clear producer responsibility system has a strong role in promoting the mitigation of plastic pollution.

B. *Selection of Alternatives*

In the process of finding out information, we found that the natural fiber is more commonly used alternatives, such as environmental protection shopping bag, environmental protection paper, etc. Natural fibers can significantly reduce the consumption of plastic production of glass fiber. However, its cost is expensive, and the technology is widely used in car manufacturing. Ford, for example, the use of natural fiberrein forced materials, the total weight of 27000 tons. The expensive nature of natural fibers has foamed the idea of them as a perfect alter native to plastic [9-14].

Table 1. Natural fibers.

Name	Advantage
A composite of wood fiber and spider silk	High strength, high rigidity and high flexibility biodegradable
PP synthetic paper	Recyclable, has good plasticity
Plastic made from sugar and carbon dioxide	Strong, transparent, scratch resistant biodegradable

By comparing plastics with possible alternatives, we can conclude that although this technology has not yet formally put into use on a large scale, we believe that their wide range of materials, environmental friendliness and high availability will enable them to be widely used as plastic alter natives in the future.

C. *National and Regional Policies*

With the rapid development of the takeaway express industry, takeaway plastic products, takeaway plastic packaging film, disposable plastic bags, etc. in people's daily life accounts for an increasingly large proportion. They make up an increasing proportion of people's daily lives. However, while plastic products have brought convenience to our lives, they have also led to the return of "white pollution". The efforts of representative countries such as China to promote the progress of the plastic restriction order have also achieved more visible results. China's plastic restriction order has also had a more visible effect in the early stages of implementation. An editorial board article in Energy Saving and Environment noted that the reduction in malls and supermarkets was around 75%. Companies such as Walmart and IKEA are also reducing their use significantly. With a reduction of about two-thirds, the annual consumption of plastic can be reduced by more than 270,000 tons, equivalent to 1.6 million tons of oil savings [15]. In Korea, the use of plastic bags plummeted by 80-90 per cent in the latter part of the year 1999 when the policy of charging for plastic bags was implemented [16].

Therefore, the State should actively promote the implementation of related policies such as the Plastic Restriction Order. Strictly control the regional environmental monitoring system and strengthen the overall assessment efforts. To strengthen public opinion and public information on the part of the public.

V. Conclusions

In the global context of inconsistent economic development and uneven distribution of resources among countries, the level of environmental pollution and the capacity to deal with it also varies among countries. Through the underlying model construction and analysis, this paper makes it clear that economically developed countries have relatively high pollution levels, but also relatively strong capacity to deal with pollution. Combined with the environmental Kuznets curve the maximum amount of single-use plastic products is derived. Finally, recommendations are made on the industrial level, the selection of alternatives and national policies to facilitate the process of environmental protection and promote sustainable development.

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