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F		2002250

Human Destiny Community:If Seas Change into Mulberry Field...

Summary

Due to rising sea levels caused by global warming, make tens even hundreds of millions of people are going to be homeless, in order to protect the people affected by climate change, we established a CGE model extension model and other models to handle EDPs reasonable placement, etc.

On the scale of the EDPs prediction problem, we use the Logistic model analysis by rising sea levels under different altitudes of indigenous people become EDP probability. The EDPs population estimate under the rising sea level is obtained by connecting the population distribution at all elevations in the world.

For countries to EDPs liability issues, we investigated the main motors of the rise in sea water for global warming, the greenhouse gas emissions associated with a rise in sea level height.

In order to solve the placement of EDPs, we calculate the Sharpley value of the responsibility for the sea level rise of each country based on its cumulative greenhouse gas emissions since 1850. And selected the EDP in moved in the degree of environmental adaptation and affordability of all countries related six important indicators, according to the index weight determination of the EDPs population proportion of countries should be properly placed. Considering EDPs of basic rights and cultural protection problem, we introduce the origin and move between the concept of fitness, the climate in the country, the distance between the countries, the national religious culture origin and move between the fitness of matrix, use the Hungarian Algorithm calculation to solve the biggest fitness matching scheme.

Finally, considering the uncertainty of policy making and implementation, we built a hybrid model of energy economy-environment based on KAYA equation and CGE model, and optimized the combination to get the optimal solution. From the analysis of China, the core is to adapt measures to local conditions.

Keywords: EDPs assignment, Shapley value, Hungarian Algorithm, hierarchical analysis, CGE Model

Contents

1 Introduction

1.1 Problem Background

According to the Intergovernmental Panel on Climate Change (IPCC) statistics, by 2100, rising global temperatures may exceed the pre-industrial temperature $3°C$, the average global sea level rise is expected between 1 to 4 feet or higher, some island countries face the danger of disappear completely. The disappearance of the island will cause a lot of people lost their homes to become environmentally displaced (EDPs: people who must relocate as their homeland becomes uninhabitable due to climate change events.) In addition, large population movements may entail the risk of loss of cultural heritage in the country of origin, including customs, languages, lifestyles and values.

Large emissions of greenhouse gases are the main cause of rising global temperatures, and the severity of the problem varies from country to country. In a world where nationalism is more popular than globalism, the urgency and rationality of EDPs placement should be emphasized.

1.2 Our work

In order to finally provide the ICM-F with recommendations for optimization and sustainable development, we developed a series of Models. From the results of each Model we propose the proposed policy, and further improve the implementation of the policy by utilizing the energy economy-environment hybrid Model based on the KAYA Equation and the CGE Model. Finally, we provide a comprehensive analysis of the above Models, including sensitivity analysis and an assessment of their strengths and weaknesses.

We also solved the following tasks:

- In low altitude area by the number of people each year, as well as the trend of rising sea levels, predicting EDPs population.
- Identifying key factors affecting sea level rise.
- Analyzing the responsibility and capability of countries in assisting EDPs, and determine the proportion of EDPs population in each country.
- The adaptation between the country of origin and the country of destination is analyzed, and the distribution scheme is given in terms of protecting EDPs rights and culture.

2 Preparation of the Models

2.1 Assumptions

In order to simplify the given problem and modify it to better simulate the real situation, we make the following basic assumptions, each of which is proved appropriately.

- We assume that the migration attribute of EDPs can only be international migration.It is clear that countries of origin are at risk of complete disappearance as a result of sea-level rise and that internal migration is impossible.So it is pragmatic to make such an assumption.

- The world's responsibility for the EDPs can be measured in terms of historical responsibility for sea-level rise. Due to the largest country in the greenhouse gas emissions are often affected by climate change's smallest country, therefore, a global approach to climate change migration will ensure that those countries that emit large amounts of greenhouse gases are held responsible for the climate change they cause, and are compensated for the sea-level rise that climate change brings. This is one kind accords with the requirement of legal fairness and efficiency.
- We should take the principle of fair to solve EDPs of resettlement problems. Each EDP is part of a cultural heritage that protects both culture and individual human rights.
- Sea level rise is determined by the thermal expansion of seawater and the loss of land ice. Although there is a great deal of uncertainty in ignoring the spatial warming patterns and climate sensitivity of the ocean, this assumption is necessary because it cannot be quantified depending on ocean ventilation and surface ice.

3 Notations

The primary notations used in this paper are listed in Table 5.

Table 1: Notations

Symbol	Definition
g	Population migration
Ele	Altitude
EDP	range of EDPs
P_{LECZ}	Coastal population
SL_i	sea level in Year i
Yi	Consecutive years i since 1960
$I_{emissions}$	Cumulative carbon dioxide emissions
w	Matrix maximum eigenvalue
λ_{max}	Feature vector
λ_{max}	Feature vector
W_i	The weight obtained from the normalization of W
CI	Consistency indicator
F_{ij}	matching degree
F_C, F_D, F_P, F_R	matching degree in climate, distance, race and religion

4 Model 1: International EDPs Population Projections

4.1 Problem Analysis

On the issue of international EDPs population prediction, we consider two aspects. On the one hand, we believe that the scale of EDPs will continue to increase with the rise of sea level. On the other hand, we believe that EDPs mainly come from low-altitude areas, such as Tuvalu, Maldives, Nauru and other island countries. A reasonable guess is that the size of EDPs is closely related to the total population of these low-altitude areas. To this end, we consulted the population data of the global low-altitude regions to establish the relevant prediction model.

4.2 Model Building

At the same time, the pressure from sea level rise will lead to a certain probability of population migration in these low-altitude areas, and this probability will also change with the change in the altitude of different areas. We call the probability of population migration population migration rate g. It is assumed that the relation between g value and altitude Ele conforms to the change law of logistics function, and the difference only lies in the direction of change. For the Logistics function of variation, the value of g of its independent variable decreases with the increase of Ele, and the maximum value of the independent variable is 1. The rationality of the guess is that when the altitude is lower than a threshold, rising sea levels will lead to serious survival oppression, population mobility in certain altitude range will be at a higher level. When the altitude higher than a threshold, due to the largely disappeared from sea level pressure, population migration probability with the increasing of altitude index decline. Logistics Equation:

$$\frac{dP}{dt} = rP(1 - \frac{P}{k})$$

We assume that population migration rate still has an effect that cannot be ignored within the range of altitude $0 \sim 20m$. The functional relationship between population migration rate and altitude is as follows:

$$\begin{cases} g(Ele') & = \dfrac{KP_0 e^{rt}}{K + P_0(e^{rt} - 1)} \\ Ele' & = 20 - Ele \end{cases}$$

Among them:

1. maximum migration rate$K$: $K = 1$
2. minimum migration rate g_0:$g_0 = 0.001$
3. rate of change$r$:r varies with annual sea level rise.

In order to simplify calculation, we divided the altitude into Nintervals of 0-1m, 1-3můůů *-20m, etc., and estimated the population of EDPs each year. The average elevation of each interval was taken as $Ele[N]$, and the population of each altitude interval was denoted as $P_{LECZ}[N]$

Calculation formula of annual EDPs population data:

$$\begin{cases} Ele[n]' & = 20 - Ele[n] \\ EDP & = \sum_{n=1}^{n=N} P_{LECZ}[n] \times g(Ele[n]') \qquad (3-1) \end{cases}$$

4.3 Model Solution

Logistics function reflects the change rate of r to low altitude to sea level rise pressure to survive, in order to determine the r value, we try to existing EDPs data (table 2), and a year of low altitude population data is forecasted. [http://sedac.ciesin.columbia.edu/data/set/lecz-urban-rural-population-land-area-estimates-v2] Assuming that the sea level rises at a constant

Table 2: Global EDP statistics in recent years:

year	EDPs(Mili.)	r
2003	20.00[https://www.unhcr.org/]	0.216
2005	19.20[https://www.unhcr.org/]	0.212
2007	37.40[https://www.unhcr.org/]	0.255
2015	65.00[https://www.unenvironment.org/]	0.277
2016	62.00[https://www.unhcr.org/]	0.282
2017	68.50[https://www.unhcr.org/]	0.286

rate of 5.2mm per year, 2000 is taken as the zero point of sea level to obtain the relative sea level data SL(mm) from 2000 to 2050, and the function relationship between r value and SL is fitted twice:

$$r(SL) = -0.23 \times SL^2 + 1.3 \times SL + 1.9$$

According to formula (3-1), the predicted EDPs population by 2050 is as follows:

Table 3: Estimated EDP value in 2020-2030,2050:

year	r	EDPs(per)
⋮	⋮	
2020	0.3003232	81377627.38
2021	0.304533328	86929581.44
2022	0.308619072	92627691.95
2023	0.312580432	98454963.06
2024	0.316417408	104393320.8
2025	0.32013	110423809.3
⋮	⋮	
2050	0.37252	235966796.7

The data shows that without concerted global action, a series of environmental problems caused by rising sea levels, such as floods and tsunamis, will force more people to move in the future. The size of the EDPs is expected to more than triple from 2020 to 23.6 million by 2050. Under the severe situation, we need to pay attention to these low-altitude areas, on the one hand, we need to carry out the restoration of the global climate environment, on the other hand, we need to carry out the reasonable placement of EDPs. In this background, the placement of EDPs will become a long-term international issue.

5 Model 2 :Reasonable Distribution of EDPs

There are two interpretations of the principle of common but differentiated liability, whether it is based on historical emissions of greenhouse gases or on economic capacity. The former is similar to the polluter pays principle, while the latter is generally regarded as a fundamental principle of domestic environmental management and an incentive principle to reduce pollution. Conversely, a principle based on economic capacity may produce a plausible justification, such as support, aid, or generosity, that weakens the moral implications of the concept of responsibility. The significance of the principle of common but differentiated responsibilities in EDPs migration and protection should be clarified. It should stipulate that countries have a responsibility to help with the migration of EDPs in proportion to their historical responsibility for sea-level rise and their ability to accept EDPs

5.1 The Man-made Factors Which Lead to Rising Sea Levels

5.1.1 Problem Analysis

To get a fair measure of responsibility, first analyze Human Factor in sea level rise Based on international research on global warming, we determine that the positive radiative forcing of greenhouse gas intensity is the most important factor contributing to global warming and sea level rise.

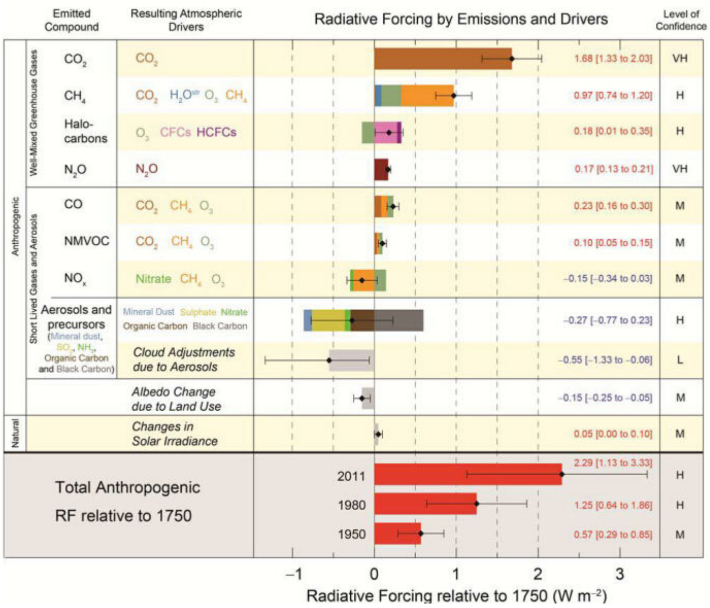

Figure 1: Radiation Force

We therefore modeled the cumulative rise in sea level over a given period and the cumulative human emissions of greenhouse gases over that period to measure countries' responsibility to the EDPs population. To this end, we established a mathematical model of carbon dioxide's influence on sea level rise, as an input-output transfer model in the subsequent responsibility allocation, mainly considering the impact of cumulative carbon emissions in the earth environment since 1960 on the thermal expansion of seawater

5.1.2 Model Bubing

Our aim is to explore how steric sea level rise are connected to cumulative carbon emissions.

Our aim is to explore how steric sea level rise is connected to cumulative carbon emissions. We discussed in the 30-80 years, within the scope of the crustal movement and other address factors have less effect on the rise in sea level, sea level rise of the main driving factor for the thermal expansion of the water and ice sheets (ice sheet) of the melt, the two jointly by the upper ocean and air temperature near ground thermal circulation influence, through certain weighted average coefficients can be transferred to the accumulative total greenhouse gas emissions (GtCO2 - eq) directly affect, below the total greenhouse gas emissions and sea level during the relative rise of modeling.

$$\Delta SL = SL(t) - SL(T_0) = -\frac{1}{\rho_0}\int_{-D}^{0} \overline{\Delta\rho(z)}^{A} dz,$$

where D is the maximum ocean depth concerned to be , ρ_0 is reference density, takenas 1026 kg m^{-3} from global average over the upper 100 m, and the oberbar represents as a global average over ocean area A, such that $\overline{\Delta\rho(z)}^{A} \equiv \frac{1}{A} int_a \Delta\rho(z) dA$ It is noted that the stratified thermal convection of sea level leads to the temperature change of seawater on a global scale, which can be ignored at a certain depth. At this maximum depth D, the Pacific Ocean is about 2100 meters deep. The linear approximate equation of state can be used to evaluate the density of the global ocean.$\Delta SL = -\alpha\rho_0\Delta T + \beta\rho_0\Delta S$ so that the steric sea level change is then related to the global, volume-weighted changes in ocean temperature,ΔT_{ocean}, and salinity, $DeltaS_{ocean}$

$$\Delta SL = \int_{-D}^{0} (\overline{\alpha(z)}^{A}\overline{\Delta T(z)}^{A} - \overline{\beta(z)}^{A}\overline{\Delta S(z)}^{A}) dz \qquad = \overline{\alpha}^{V} D\Delta T_{ocean} - \overline{\beta}^{V} D\Delta S_{ocean}$$

Considering the dynamic equilibrium relationship of global water cycle, the change of continental water resources reserves during the period from 1960 to 2018 is investigated, and ocean in the world generally has a certain trend of desalination, but there is no significant salinity change, then

$$\Delta SL = -\frac{1}{\rho_0}\int_{-D}^{0} \overline{\Delta\rho(z)}^{A} dz \approx \overline{\alpha}^{V} D\Delta T_{ocean},$$

where a global-mean value of $\overline{\alpha}^{V} = 1.572 \pm 0.147 * 10^{-4} K^{-1}$

The radiative heat flux at the sea surface increases logarithmically with increasing atmospheric CO2 [Myhre et al., 1998]

$$F(t) = a\, ln(CO_2(t)/CO_2(t_0)))$$

where $a = 5.35W \cdot m^{-2}$assuming an adjustment of only the upper atmosphere, the stratosphere. The resulting heat input then leads to a surface warming, represented by

$$\Delta T_{surface}(t) = \Delta T_{surface:2\times CO_2} \frac{ln(CO_2(t))/CO_2(t_0)}{ln2}$$

where the climate sensitivity,ă$\Delta T_{surface:2\times CO_2}$, is the surface temperature increase for a doubling of atmospheric CO2ăand varies from 2K to 4.5K,with a mean of 3K,from a range of climate models [Knutti and Hegerl, 2008]. Similarly, given the relationship between ocean temperature and carbon dioxide concentration,

$$\Delta T_{ocean}(t) = \Delta T_{ocean:2\times CO_2} \frac{ln(CO_2(t))/CO_2(t_0)}{ln2}$$

the climate sensitivity,ă$\Delta T_{ocean:2\times CO_2}$, is the ocean temperature increase for a doubling of atmospheric CO2 and related to $\Delta T_{surface:2\times CO_2}$ by a fixed coefficient γ which is 0.25 to 0.3 for

GENIE [Cao et al., 2009] and 0.4 to 0.6 for UVic Earth System model[Archer et al., 2009] for a timescale of 500 to 1000 years

In the two research models, the ratio of the sensitivity of the atmosphere to the carbon dioxide concentration of the ocean varies with the changes of ocean currents and ice sheets in the long-time range, which is not significant on the time scale discussed in this question. Speculate it$\Delta T_{surface:2\times CO_2}$between0.75k to 1.24k
The concentration of carbon dioxide in the atmosphere mainly depends on the historical accumulation of carbon dioxide emissions.

$$(CO_2(t) = a \cdot I_{emissions}(t) + CO_2(t_0)$$

where a is a convert factor for gas emissions to concentration $(GtCO_2 \cdot ppm^{-1})$,$I_{emissions}(t)$ is Cumulative emissions of greenhouse gases from year 1959

5.1.3 Model Solution

The results show that $CO_2(t_0) = 314.25924(ppm), a = 0.000049(GtCO_2 \cdot ppm^{-1})$

The derived formula of the height of sea level rise and the cumulative greenhouse gas emissions is obtained:

$$\Delta SL \approx \overline{\alpha}^V \cdot D \cdot \Delta T_{ocean:2\times CO_2} \frac{ln(a \cdot I_{emissions}(t) + CO_2(t_0))/CO_2(t_0)}{ln2}$$

where
$\overline{\alpha}^V = 1.572 \pm 0.147 * 10^{-4} K^{-1} D = 2100(m) \Delta T_{ocean:2\times CO_2} = (0.74, 1.24)k; a = 0.000049(ppm/GtCO2 - eq); C$
; That is, the height of sea level rise in a given period is positively correlated with the amount of cumulative global carbon emissions during that period, and the rise in sea level caused by each unit of greenhouse gas emissions increases with the increase in total emissions

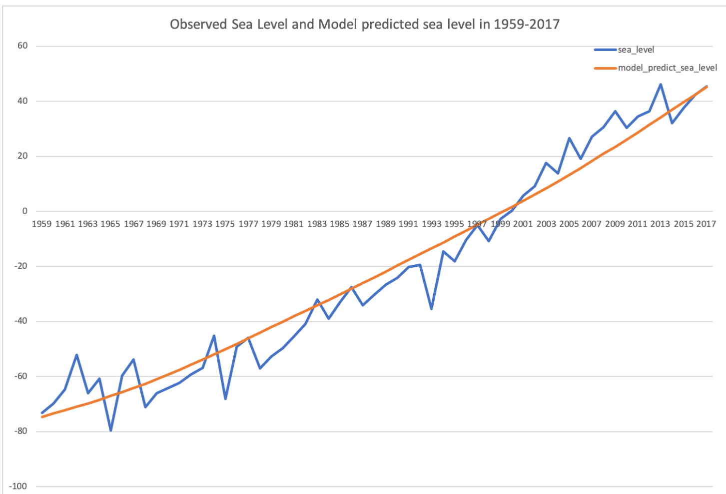

Figure 2: Observed Sea Level and Model predicted sea level

5.1.4 Time series prediction

Considering that the sea level height in each year is not completely independent, we also used the time series model to predict the sea level height, and set the 95% confidence space to obtain the following results. The dashed line is 95% confidence space, the blue line is the actual observed value, the red line is the prediction of the above model, and the green line is the prediction of the time series model. The observed time series prediction for the period of 2018-2050 is consistent with our theoretical model of the near smooth transition trend.

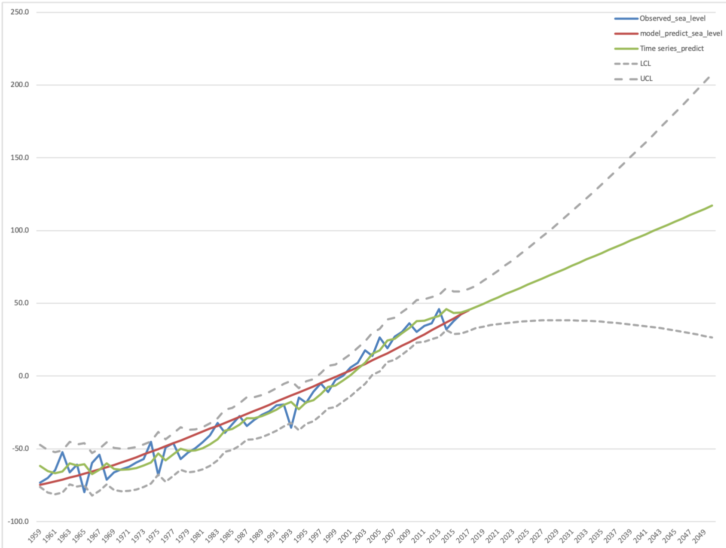

Figure 3: TimeSeriesPredict

5.2 Model 3 Responsibilities and Capabilities

5.2.1 Responsibility

a **The state environmental protection investment** :Can be obtained by the model 2 analysis, CO_2 for the rise in sea level has a direct impact, so we think that a country will be in the CO_2 emissions on the global EDPs acceptance of responsibility.

b **National environmental investment**: the impact of a country's historical total carbon emissions on climate change is undoubtedly huge, but we cannot ignore the contribution of some countries to environmental protection over the years. Greenhouse gas emissions are something that countries have to do in the course of their industrial development. Even "victimized small island states" like Tuvalu emit greenhouse gases to a greater or lesser extent.Therefore, in an objective analysis, we should not only consider the CO_2emissions of each country, but also consider the intensity of national environmental investment as one of the indicators.

In order to propose a fair burden-sharing scheme, we propose the following four axioms for the word fairness

1 Symmetry: the distribution of responsibilities among countries does not vary with each person's mark or order in cooperation.

2 Effectiveness: the sum of the benefits of countries equals the benefits of cooperation.

3 Redundancy: a country should not be held responsible if it does not affect the height of sea level rise in consideration.

4 Additivity: when national groups are considered separately, the distribution of responsibilities within each national group should not be related to the distribution of responsibilities among other groups.

Any assignment problem that satisfies the above axioms has been proved to be fairly distributable by the Shapley Value Method.

Essentially, the Shapley value is the average expected marginal contribution of one player after all possible combinations have been considered. While not perfect, this has proven a fair approach to allocating value. In our distribution method, in order to make the distribution scheme fair, the carbon dioxide emissions of each country are taken as input and the rise of sea level as negative output in the sense of punishment. Sharpley model is applied to calculate the Shapley distribution rate of each country. Thus, most countries are willing to accept the notary nature of the scheme. In model 1, we have demonstrated and explored the relationship between the height of global sea level rise and global cumulative greenhouse gas emissions (GtCO2-eq). The following is the Shapley value calculated according to the greenhouse gas emissions of major global economies from 1850 to 2017, and the Shapley value in proportion to the Shapley value to calculate the country's responsibility for sea level rise.

5.2.2 Ability

We believe that EDPs should have the basic rights of protection, namely the right to life, the right to freedom of migration, the right to environment, to ensure the basic production and life of EDPs under the action of migration. Therefore, we propose the concept of national EDPs environmental acceptability. The obstacle factors affecting EDPs environmental acceptability are discussed from four aspects: material capital and financial capital in living development level, living ecological environment and environmental perception in living space, neighborhood communication and social integration in social communication space, etc

a Natural capital: the comfort of a refugee's living space in the country of entry is based on owning a piece of land. At a time when we have just lost our ancestral home, we know from moving to a new country that they are longing for a place to live. In addition to the impact of the national environmental investment on the living environment discussed above, the impact of countries with high population density on their resettlement is undoubtedly

Table 4: TableName

Country	SUM	Shapley_rate
World	2430694.00	100.00%
United States	585906.00	31.24%
European Union (27)	384312.00	20.45%
China	298538.80	15.85%
Russia	154926.00	8.14%
Least Developed Countries	70943.90	3.62%
India	103533.20	5.38%
United Kingdom	97118.00	5.03%
Japan	74856.90	3.83%
Ukraine	45175.60	2.24%
Canada	44117.90	2.18%
Brazil	41734.69	2.05%

negative. Therefore, we can include the population density of each country as one of the obstacles

b Financial capital: whether immigrants can have a normal livelihood development is the precondition for them to accept the environment of the country of entry. In our model, many indicators, such as national GDP per capita, employment opportunities, and Engels coefficient, are taken into account. National strength can measure domestic employment opportunities, employment is a necessary prerequisite for personal sustainable development. Engel's coefficient can measure the degree of wealth and poverty of a family to some extent. In addition, access to national life-enhancing services such as primary health care, referral systems, specialized health services, psychosocial medical units and child health support is needed to deal with trauma and trauma in desirable destinations.

c Cultural acceptance: different regions have different beliefs, which can lead to misunderstandings, conflicts and discrimination. Whether a culture is inclusive plays a role. In addition, as the official languages, customs, rituals and so on vary from place to place, it may become a burden of communication between immigrants and local residents, thus affecting the acceptance of culture. In order to simplify the model and improve the effectiveness of the model, we chose several key indicators in the comprehensive evaluation index: the historical total carbon dioxide emissions, the total amount of domestic environmental investment in GDP, the population density of the country of immigration, the employment rate, the per capita GDP, and the Engel coefficient.

5.3 Model Solution

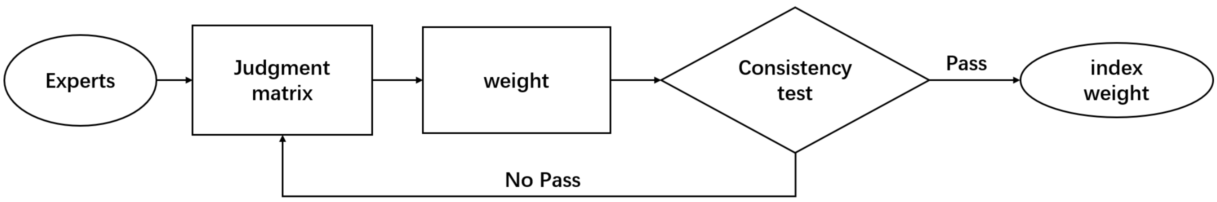

Figure 4: The process of Model 2

In order to make a reasonable allocation of world EDPs, we establish a judgment matrix of each element for relevant indicators:

Table 5: Judgment matrix

Indicator	CO_2	per capita GDP	employ	pop. density	Engel coe.	env. protection
CO_2	1	3	2	5	4	3
Per capita GDP	$1/3$	1	0.5	3	1	2
employ	0.5	2	1	4	2	3
pop. density	$1/5$	$1/3$	1/4	1	1/3	1/4
Engel coe.	1/4	1	0.5	3	1	0.5
env. protection	1/3	1/2	1/3	4	2	1

By calculation, the judgment matrix has good consistency and the corresponding weights of each element are obtained

Feature vector$W$:

$$\overline{W_i} = \sqrt[n]{M_i} = \sqrt[n]{\prod B_i}$$

The weight obtained from the normalization of W:

$$W_i = \frac{\overline{W_i}}{\sum \overline{W}_i}$$

Matrix maximum eigenvalueλ_{max}:

$$\lambda_{max} = \sum \frac{(BW)_i}{nW_i}$$

Consistency indicatorCI

$$CI = (\lambda_{max} - n)(n-1)$$

The calculation results are as follows:

Table 6: eigenvalue

Indicator	CO_2	per capita GDP	employ	pop. density	Engel coe.	env. protection
Weight	0.3586	0.0457	0.231	0.1375	0.103	0.1243

CONSISTENCY INDICATOR:$CI = 0.0528 \quad CR = 0.0419 < 0.1$

We turn to the various countries related index data, has carried on the weighted score to countries. For preliminary sure should be EDPs into more countries in these countries, we take the factor weights on the basis of the history of CO2 emissions greatly, the top 15 countries ranked, to other elements of the weighted 15 countries, after we got the updated list, to be sure. As countries environmental protection investment accounted for the data is incomplete, we are here in addition to the conservative of the indicators, to get the final result of the deviations can be expected.

Table 7: The result of Model 2

Country	CO2	ZCO2	Zpop	Zemp	ZGDP	ZEngel coe.	Zenv. Protection	Score	RANK
United States of America	288749.22	11.04773	-0.14533	-2.60849	2.08025	0	0	3.63854758	1
China	205895.28	7.81269	-0.36733	0.81288	-0.53105	0	0	2.89959956	2
Russian Federation	99867.74	3.67284	0.74331	-0.52038	-0.27502	0	0	1.19302666	3
Germany	55859.12	1.95451	-0.3939	0.52858	1.53222	0	0	1.01566829	4
Japan	57992.98	2.03783	-0.40786	0.16586	1.72937	0	0	0.98822867	5
Canada	26456.89	0.8065	2.14075	0.89131	1.60363	0	0	0.81343491	6
India	48218.3	1.65618	-0.41474	0.38153	-0.57558	0	0	0.58394371	7
France	23858	0.70503	-0.35285	0.54819	1.45658	0	0	0.56361015	8
Italy	21634.12	0.6182	-0.38723	0.16586	1.15775	0	0	0.40149439	9
Mexico	17744.44	0.46632	-0.28107	-0.02041	-0.15729	0	0	0.12803537	10
Poland	20263.18	0.56467	-0.3539	-0.41254	-0.21408	0	0	0.06158469	11
United Kingdom	33309.8	1.07407	-0.39973	-2.334	1.48952	0	0	0.03254884	12
South Korea	16431.48	0.41506	-0.41817	-1.1674	0.33499	0	0	-0.0938781	13
South Africa	18046.48	0.47812	-0.21503	-0.81448	-0.59802	0	0	-0.1087457	14
Ukraine	25637.48	0.77451	-0.30326	-2.334	-0.52045	0	0	-0.3468356	15
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By the above data, we in Canada, for example, from 1960 to 2018, the historical total CO_2emissions compared with India is less, but its population density is small, the employment rate, per capita GDP are at a higher level, in other words, Canada has certain responsibility EDPs population in the world, and its ability to undertake the EDPs is located in the world, its comprehensive ranking is relatively high. Through this model, the global EDPs population can be roughly the allocation quantity. Considering the national actual situation, we think that there is another solution: countries with higher rankings can not as a move, but rather to provide funds, technology and other aspects of the aid will be EDPs has certain conditions of population migration to other countries, such EDPs resettlement plan can better solve the problem of EDPs own ethnic culture protection.

6 Model 4: EDPs Cultural Preservation Issues

6.1 Problem Analysis

The distribution of EDPs population proposed by Model 2 is only in quantity. For EDPs from different regions, which countries they are settled in can best satisfy the EDP's survival and cultural rights.

To this end, we define the inter-country fitness $Fij$from four indicators that are easy to quantify or investigate to measure the matching degree between the countries of emigration and the countries of immigration. These four indicators are climate, distance, race and religion.

Take climate as an example: climate differences between countries of departure and countries of arrival will affect the environmental adaptability of EDPs living in countries of entry. The distribution of global climate is shown in the following figure:

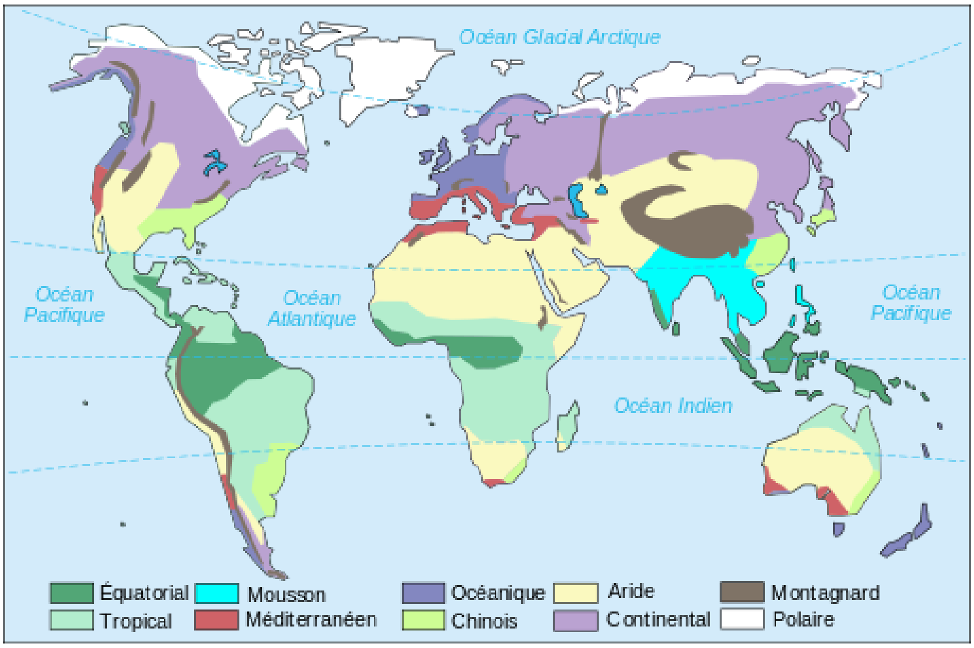

Figure 5: Global climate map:

6.2 Model Building

We ranked them according to the differences of climatic conditions in different countries. The closer the climatic conditions were, the higher the fitness between them. The climatic fitness was marked by F_C. Of course, climate-induced environmental adaptation is limited, so we need a variety of indicators to measure the fitness between countries of origin and countries of origin.

For this reason, we select four levels of climate, distance, race and religion to measure the matching degree of an incoming country and an outgoing country, corresponding symbols are F_C,F_D,F_P and F_R, respectively.

For the convenience of calculation, we divided the fitness into 5 grades: $1 \sim 5$. This paper tries to calculate F_{ij}, and USES the Hungarian algorithm to match the countries of departure with the countries of entry. Here in order to simplify the calculation, we only choose five suffer severe low altitude countries (Tuvalu, Maldives, Kiribati, Marshall Islands, Douban), and model 2 conclusions in the top five countries settle (United States of America, China, the Russian Federation, Germany, Japan) EDPs culture protection problem analysis

6.2.1 Model Solution

When we checked the four indicators, we found that due to the incomparability of ethnic differences between countries (it was almost impossible to find the similarity between any country that moved in and one country that moved out), we decided to remove this indicator. For climate, distance and religion, we used the method of model 2 to calculate the weight:

Table 8: F_C, F_D, F_R,judgment matrix and its weight

Index	climatic	distance	religious	weight
climatic	1	0.5	0.25	0.1429
distance	2	1	0.5	0.2857
religious	4	2	1	0.5714

The actual situation of three indicators in 10 countries was investigated to obtain their fitness matrix:

$$F_{Cij} = \begin{Bmatrix} 3 & 2 & 3 & 2 & 3 \\ 2 & 3 & 2 & 3 & 2 \\ 1 & 1 & 1 & 1 & 1 \\ 2 & 2 & 2 & 1 & 2 \\ 2 & 3 & 2 & 2 & 3 \end{Bmatrix} F_{Dij} = \begin{Bmatrix} 3 & 5 & 3 & 2 & 4 \\ 2 & 1 & 2 & 1 & 2 \\ 4 & 2 & 4 & 4 & 3 \\ 5 & 4 & 5 & 5 & 5 \\ 1 & 3 & 2 & 1 & 1 \end{Bmatrix} F_{Rij} = \begin{Bmatrix} 4 & 1 & 5 & 4 & 5 \\ 1 & 1 & 1 & 1 & 1 \\ 2 & 1 & 2 & 2 & 2 \\ 4 & 1 & 5 & 4 & 5 \\ 1 & 1 & 1 & 1 & 1 \end{Bmatrix}$$

F_{Cij}, F_{Dij} and F_{Rij} were standardized and weighted to calculate F_{ij}.

$$F_{ij} = F_{Cij} \cdot F_{Ce} + F_{Dij} \cdot F_{De} + F_{Rij} \cdot F_{Re}$$

F_{ij}	Tuvalu	Maldives	Kiribati	Marshall Islands	Douban
United States of America	0.81	-0.06	1.16	0.41	1.36
China	-0.65	-0.64	-0.65	-0.64	-0.65
Russian Federation	-0.11	-0.85	-0.11	-0.11	-0.30
Germany	1.00	-0.26	1.35	0.80	1.35
Japan	-0.84	-0.25	-0.65	-0.84	-0.64

In order to get the matching relationship between countries, we use the Hungarian Algorithm, to calculate the maximum match fitness matrix solution.

$$z_{max} = \sum_{i=1}^{n} \sum_{j=1}^{n} F_{ij} x_{ij}, \qquad \text{CONSTRAINT CONDITION:} x_{ij} = \begin{cases} 0, \\ 1 \end{cases}$$

Maximum match: 1.713

$$\text{MATCHING MATRIX} = \begin{Bmatrix} 1 & 5 \\ 2 & 4 \\ 3 & 1 \\ 4 & 3 \\ 5 & 2 \end{Bmatrix} \Rightarrow \begin{Bmatrix} UnitedStatesofAmerica & Douban \\ China & MarshallIslands \\ RussianFederation & Tuvalu \\ Germany & Kiribati \\ Japan & Maldives \end{Bmatrix}$$

From the conclusion, we can get the optimal matching relationship between the countries of origin and the countries of immigration, such as: US-Nauru, China-Marshall islands. By using a similar calculation method of this model, each country that needs to be responsible for EDPs can provide reasonable assistance to countries that are prone to producing EDPs, which will be an optimal solution considering the survival and culture of EDPs. Of course, this allocation strategy can be adjusted to some extent. For example, when the economic development level of these low-altitude areas is relatively high, a series of preventive measures for land reclamation can be carried out, and the responsible countries of immigration can provide non-immigrant policy assistance in terms of funds.

7 Model 5: Policy Formulation and Policy Modeling

7.1 Model Building

7.1.1 Theoretical Framework

The calculable general equilibrium Model (CGE Model) is a powerful tool for the analysis of economic systems.By combining the CGE Model with the KAYA Equation, we build a hybrid Model of three-sector energy economy through the design of Model framework and the setting of core functions.Based on the input and output data of 2012, GAMS program was used to solve the Model variables and simulate the relevant data. **Model Framework Design**

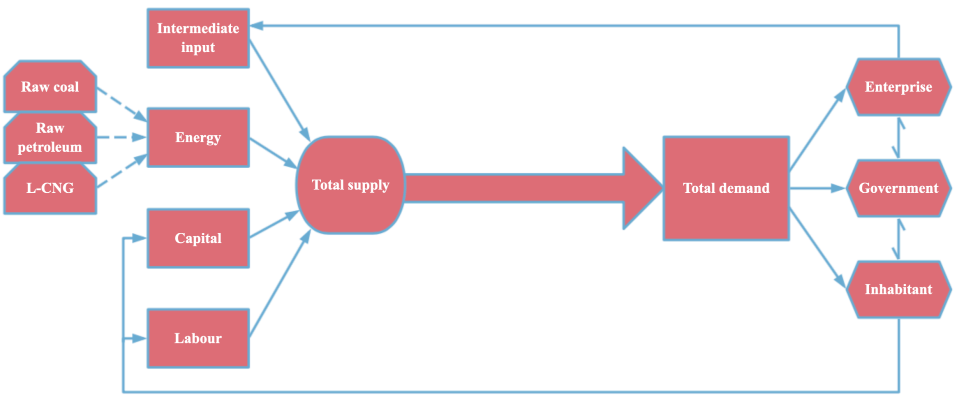

Figure 6

Figure 6 is the basic frame diagram of the three-sector economic structure we constructed. In the figure, enterprises, government and residents are the main sectors, and people's income mainly depends on consumption, investment and government expenditure.Intermediate inputs, energy, capital and labor jointly constitute factor markets, which are provided by production to satisfy enterprises, governments and residents. The circular flow of capital links the three sectors of the economy through factor markets.

KAYA Equation Variable Decomposition

Using the KAYA identity proposed by YoichiKaya, a Japanese scholar, to express the relationship between carbon emissions and related variables, we decomposed the variables and combined it with the CGE model to build an energy economic environment model. KAYA equation is expressed as:

$$CO_2 = P \times \frac{GDP}{P} \times \frac{E}{GDP} \times \frac{CO_2}{E}$$

In this equation, carbon dioxide emissions are decomposed into four factors related to human production activities. Among them, P represents the total population and reflects the scale effect of carbon emissions in the social environment.GDP/P is per capita GDP, which is an important indicator to analyze a country's macroeconomic environment.E/GDP refers to energy consumption intensity, which refers to the energy consumption per unit of GDP within a certain period of time. It reflects the dependence of economic growth on energy consumption. It is an important indicator to measure a country's energy utilization efficiency, which is closely related to economic growth pattern, energy consumption composition and energy technology level. $CO2/E$ refers to the carbon emission intensity per unit of energy consumption. The carbon emission coefficient of each energy is certain. Different types of energy have different carbon emissions, which reflects the relationship between energy structure and carbon emissions.

In summary, the KAYA equation summarizes the factors affecting carbon emissions into four aspects: population, economy, energy and technology. We selected industrial structure and energy intensity as independent variables, and GDP, labor input, total energy consumption and carbon dioxide emissions as dependent variables, to simulate the changes of energy economic environment under the adjustment of different policy variables.

7.1.2 Model Design and Data Processing

Based on the general equilibrium theory, this paper introduces the energy module with technology accumulation mechanism on the basis of the traditional CGE Model. The model includes production module, consumption behavior module and energy module. The main module functions are designed as follows:

1.Production Module

The production module function is set by constant substitution elastic production function, namely CES production function, which is the most frequently used nonlinear function in CGE Model. Its standard format is as follows:

$$q = f(x_1, x_2) = A(\delta_1 x_1^{\rho} + \delta_2 x_2^{\rho})^{\frac{1}{\rho}}$$

Where, q stands for total output;$x1$ and $x2$ are the corresponding two input elements; Parameter A is the production efficiency or scale factor, that is, the total factor productivity in economics. Is related to the elasticity of substitution and can also be understood as the elasticity of substitution between two elements.1 and 2 are the share parameters of the two input factors respectively, which are related to the contribution degree of the input amount of the two elements in the total output. Generally speaking, the total output is equal to the sum of the total input of each factor, that is, the total contribution of all factors is equal to 1, so 1+ 2=1. In the CGE Model, the CES production function is often written directly as:

$$q = f(x_1, x_2) = A(\delta_1 x_1^\rho + (1-\delta_1)x_2^\rho)^{\frac{1}{\rho}}$$

In microeconomics, enterprises always seek the most economical input state in the production process, that is, they follow the principle of minimization of input cost. Therefore, when the output is given, the enterprise behavior is shown as:

$$min_{x_1,x_2,\lambda} L = \omega_1 x_1 + \omega_2 x_2 - \lambda[A(\delta_1 x_1 \rho + \delta_2 x_2 \rho)^{\frac{1}{\rho}} - q]$$

We will simplify production module, input and output elements as labor, capital, energy, and intermediate inputs such as four parts, because the CGE model CES production function usually contains only two inputs, extra inputs can lead to the elasticity of substitution between input factors of consistent, so we take the five layers of nested CES build production module functions. The diagram of CES nesting is shown in figure 7.

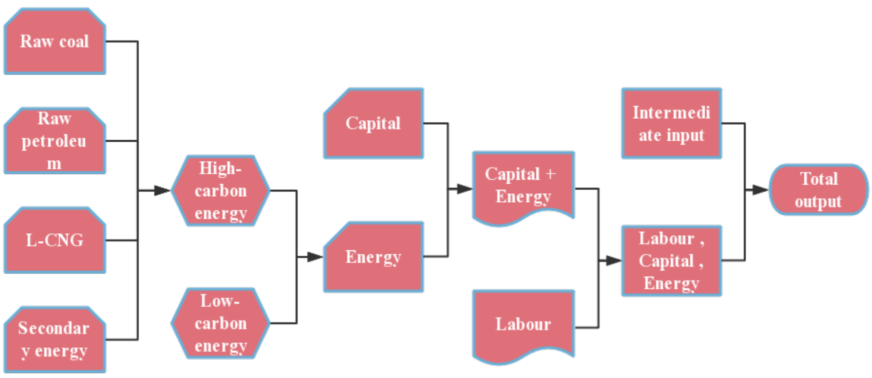

Figure 7

2.Energy Module

The energy module is based on section 8.2.1.2 of this paper, and the subdivision variables decomposed by KAYA formula are expressed as functions, which are combined with CGE Model to form the energy module of the hybrid Model. This module mainly includes the accounting of carbon emissions, the functional expression of industrial structure and energy intensity. In the calculation of carbon emissions, considering the difficulty of data acquisition and the accuracy of the calculation results, this paper selects the primary consumption of coal, oil and natural gas as three major fossil energy sources, and calculates the total carbon emissions using the emission coefficient method. The function is expressed as follows: $CO_{2i} = \sum_j E_{i,j} \times \theta_j (j = coil, oil, gas)$

3.SAM table construction

Formula 11 shows that the total carbon emission CO_{2i} is equal to the sum of the energy consumption $E_{i,j}$ (coal, oil, natural gas) of country i multiplied by the carbon emission coefficient of corresponding energy θ_j.

7.2 Model solution

7.2.1 Policy Simulation Analysis

According to the energy economic environment Model established in this paper, the change trend of the world economic environment and energy environment is simulated when the proportion of the secondary industry is reduced by 1%, 3% and 5%, and the proportion of the tertiary industry is increased by 0.5%, 1% and 2% respectively.

1. Energy-Economy-Environment Analysis

Analysis on the influence of industrial structure on energy economic environment

As shown in table 1, the reduction of the proportion of the secondary industry will significantly affect the emission reduction. Among other variables, GDP, total social capital stock, labor input and industrial structure have obvious positive nonlinear relations. In terms of the tertiary industry, the service transformation of the industrial structure plays a significant positive role in promoting economic and social development. From the sensitivity analysis, the total energy consumption and carbon dioxide emissions are the most sensitive to industrial adjustment. According to table 3, the improvement of energy efficiency of three different fossil fuels will promote the green development of social economy.

Table 9: Simulation results of energy efficiency (unit: %)

	coal2	petr2	gas2
GDP	0.03	1.42	1.06
CS	0.05	1.21	1.19
LS	0.07	1.32	1.08
SCO	-2.45	-2.01	-1.89

According to the sensitivity analysis, of the three energy sources, the improvement of coal efficiency was the most obvious, reaching 2.45%. Improved coal efficiency will significantly reduce the air pollution caused by coal blending; Oil, on the other hand, contributed even more to economic growth, with GDP growing by 1.42%. The sensitivity of natural gas to various variables is relatively balanced, between 1% and 2%. However, with the continuous promotion of the use of natural gas, its contribution to the economy and the environment will be further improved.

2. cost effectiveness analysis

Since the improvement of energy environment brought by the reduction of industrial structure will make the overall economy show a downward trend to some extent, we take the ratio of the rate of change of each economic variable and the decline of carbon dioxide emissions as the marginal emission reduction loss of each economic variable to measure the cost effectiveness of the adjustment of policy variables. Table 4 shows that with the continuous decrease of the proportion of secondary industry, the marginal emission reduction loss of various economic variables shows an increasing trend.

7.2.2 Analysis of Optimal Combination Strategy

On the premise of setting the above simulation variables, this paper lists a total of 27 different strategy combinations, and obtains the variation of each variable under different combinations (see table 6).

Table 10: Industrial structure adjustment under the marginal loss reduction of CO2

	-1	-3	-5
GDP	0.71	0.87	0.94
CS	0.29	0.55	0.77
LS	0.42	0.57	0.78

The results show that most of the combined strategies are to reduce the economic variables while improving the carbon emissions, which is not a desirable solution for China in the medium term of industrial development. There are only four combined strategies to achieve the reduction of carbon emissions under the premise of ensuring economic growth (decoupling Model), namely "-1, 1, -1", "-1, 2, -1", "-1, 2, -3" and "-3, 2, -1" (underlined in the table).

(1) Of the four combined strategies, "-1, 1, -1" strategy has the least significant effect, and is not very sensitive to economic growth or the improvement of energy environment.

(2) The "-1, 2, -1" combination strategy is the most sensitive to economic variables, GDP growth can reach 3.24%, and it also contributes 2.09% to the improvement of carbon emissions.

(3) The "-1, 2, -3" combination strategy is relatively balanced in its sensitivity to all variables, and can achieve a 2.42% reduction in carbon emissions on the premise of ensuring a GDP growth rate of 2.18%.

(4) The "-3, 2, -1" combination strategy is more inclined to the improvement of energy environment, and the carbon emission data is the most sensitive, reaching a 3.28% reduction, which is the highest among the four combination strategies. Meanwhile, the GDP growth rate can be stabilized at 2.08%.

7.2.3 Discussion of Model Results

By combining the CGE model with KAYA equation, we construct the CGE Model of energy economic environment, and simulate the changes of carbon emissions and the overall social economy in terms of industrial structure and energy efficiency. On the whole, the reduction of the proportion of the secondary industry will reduce the overall energy dependence of the society and drive the economic environment towards intensive development, but it will bring about serious negative economic growth. The increase of the proportion of the tertiary industry will boost the total factor productivity of the society, and the economic growth trend will be significant. Meanwhile, it will also have a positive impact on the improvement of the social energy environment. The improvement of energy efficiency reduces the social total energy consumption, energy and environment problem improved obviously, improve the efficiency of enterprise's production, the increase of the output value has a certain contribution to society. Combined with our analysis of China as a result, the conclusions and Suggestions are presented:

1. According to the simulation results show that carbon emissions are not the bigger the better, to properly according to the regional environment.

2. The implementation of a single carbon emission reduction plan depends largely on the "concession" of economic development, which will lead to an unbalanced state between economic development and energy environment.

strategy	GDP	CS	LS	E	SCO	TCOEI
-1. 0.5. -1	-0.11	-0.12	-0.21	-1.43	-1.25	-0.9
-1. 1.-1	1.02	0.29	0.24	-2.18	-1.62	-1.63
-1. 2. -1	3.24	1.18	1.35	-2.94	-2.09	-2.97
-1. 0.5. -3	-1.17	-1	-1.02	-1.5	-1.58	-1.09
-1. 0.5. -5	-3.32	-2.79	-2.89	-1.73	-2.45	-1.31
-1. 1. -3	-0.04	-0.59	-0.57	-2.25	-1.95	-1.82
-1. 1. -5	-2.19	-2.38	-2.44	-2.48	-2.82	-2.04
-1. 2. -3	2.18	0.3	0.54	-3.01	-2.42	-3.16
-1. 2. -5	0.03	-1.49	-1.33	-3.24	-3.29	-3.38
-3. 0.5. -1	-1.27	-0.98	-1.01	-2.69	-2.44	-1.29
-3. 1. -1	-0.14	-0.57	-0.56	-3.44	-2.81	-2.02
-3. 2. -1	2.08	0.32	0.55	-4.2	-3.28	-3.36
-3. 0.5. -3	-2.33	-1.86	-1.82	-2.76	-2.77	-1.48
-3. 0.5. -5	-4.48	-3.65	-3.69	-2.99	-3.64	-1.7
-3. 1. -3	-1.2	-1.45	-1.37	-3.51	-3.14	-2.21
-3. 1. -5	-3.35	-3.24	-3.24	-3.74	-4.01	-2.43
-3. 2. -3	1.02	-0.56	-0.26	-4.27	-3.61	-3.55
-3. 2. -5	-1.13	-2.34	-2.13	-4.5	-4.48	-3.77
-5. 0.5. -3	-3.19	-2.87	-2.89	-4.71	-4.32	-1.59
-5. 1. -1	-2.06	-2.46	-2.44	-5.46	-4.69	-2.32
-5. 2. -1	0.16	-1.57	-1.33	-6.22	-5.16	-3.66
-5. 0.5. -3	-4.25	-3.75	-3.7	-4.78	-4.65	-1.78
-5. 0.5. -5	-6.4	-5.54	-5.57	-5.01	-5.52	-2
-5. 1. -3	-3.12	-3.34	-3.25	-5.53	-5.02	-2.51
-5. 1. -5	-5.27	-5.13	-5.12	-5.76	-5.89	-2.73
-5. 2. -3	-0.9	-2.45	-2.14	-6.29	-5.49	-3.85
-5. 2. -5	-3.05	-4.24	-4.01	-6.52	-6.36	-4.07

8 Conclusion

1. **If carbon emissions are not controlled, more EDPs will appear.** Sea level rise is the immediate cause of the disappearance of some island nations, and tens of millions of people could lose their homes in the future if carbon emissions are not controlled.

2. **The allocation of EDPs must be addressed according to both capability and responsibility**.According to the "common but differentiated responsibilities", while countries assume their climate responsibilities, some developed countries also have the responsibility to lend a helping hand to developing countries to enhance their capacity to withstand climate risks and implement migration planning and management.

3. **If carbon emissions are not controlled, more EDPs will appear.** Sea level rise is the immediate cause of the disappearance of some island nations, and tens of millions of people could lose their homes in the future if carbon emissions are not controlled.

4. **We should not only allocate EDPs quantitatively, but also consider their fitness between countries of origin and countries of entry.** The factors that may affect the survival and cultural protection of EDPs after immigration between countries of origin and countries of immigration should be taken as the measurement index, and the adaptability between countries should be systematically analyzed and solved.

5. **Policy implementation is necessary and needs to be tailored to local conditions.** In order to keep the balance between the world economic development and the energy environment, the differentiated needs of countries with different levels of development should be fully considered in the implementation of policies.

9 Strengths and Weaknesses

9.1 Strengths

1. The Shapley value is the only and proven fair way to calculate the responsibility of countries in the face of climate problems.

2. Based on the radiation intensity Model caused by the concentration of greenhouse gases in the atmosphere, the thermal expansion of global surface waters is estimated, and the earth's prediction Model of global cumulative greenhouse gas emissions based on the rise of sea level is established. The results are verified by cross comparison with other time series Models.

3. Considering in the process of sea level rise, coastal city residents affected by the situation of quantitative, converts coasts discrete natural disasters to the nature of coastal residents to continuous variation of pressure, low altitude population migration rate g and Logistics function relationship between the altitude, to better predict the EDPs in statistics.

4. The mixed Model of energy economy-environment based on KAYA equation and CGE Model established by us deeply considers the contradictory relations and changing laws among energy, economy and environment. The implementation process of the simulation policy is comprehensive and objective.

9.2 Weaknesses

1. In the Model of seawater rise and cumulative greenhouse gas emissions, we do not specifically discuss the seawater increment caused by ice sheet melting. Only linear estimation of thermal expansion of seawater is used to reduce partial error.

2. When calculating the value of Shapley, we cannot calculate the value of Shapley for all economies due to the limited computing power of computers. After carefully considering the computational power and algorithm scale, we only selected the top 11 economies with historical cumulative greenhouse gas emissions, whose total greenhouse gas emissions accounted for 78% of the world's total emissions in the same period, which is enough to describe the EDPs distribution problem in the world.

3. In terms of the selection of factors affecting national capacity, on the one hand, the factor integrity is not strong; on the other hand, considering the interaction among factors, the weight independence of factors may be relatively weak, which will lead to the change of the final size of country C_{ij} .

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