A Comprehensive Programme for the Resettlement of Climate Refugees

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Abstract: The placement of environmentally displaced persons is imminent. Involving as many countries as possible in the resettlement of environmentally displaced persons, while protecting their culture and human rights, are the primary goal of the resettlement program. However, countries may refuse to participate in resettlement programs if their interests are not fully considered. The rights of the environmentally displaced persons cannot be protected. The model involves the interests of all parties to ensure the wide participation of all countries in the world. Then, we use quantitative assessment to assess the risk of cultural loss and protect culture and human rights of environmentally displaced persons by controlling this risk. Firstly, in order to calculate the number of people who are likely to be environmentally displaced persons in the future, we build a prediction model based on Markov Chain. By analyzing the average altitude of each country and the predicted sea level rise, we calculate the number of countries likely to be submerged over time. Combining the projected future population of each country, we calculate the total number of people at risk of becoming environmentally displaced persons. Secondly, we link the number of environmentally displaced persons that countries should place with the two goals of human rights protection. Establish Double-Score model to allocate the number of people that each country should place reasonably. The model takes into account countries' carbon emissions and their suitability for migration. The two integral indexes in the model are as follows: Score of carbon dioxide emission. The higher a country's score, the more responsibility it has to accommodate environmentally displaced persons. The index is converted from the country's per capita carbon emissions and total carbon emissions, using the Paris Climate Agreement's calculation of carbon emissions. Score of suitability for immigration. The lower the Score of a country, the higher the Score of carbon emission can be deducted. Meanwhile, the better a country's cultural and human rights protection of environmentally displaced persons, the higher the score. We encourage countries to actively protect the human rights and culture of refugees. As a part of its commitment to the Paris Climate Agreement, the countries of the world must keep their total score below the set threshold.

1 Introduction

Recently, the United Nations officially recognized the EDP as refugees, who have to leave their countries because of climate change and rising sea levels. This means that the international community has begun to think about the growing problems with the environmentally . Where will the environmentally go? Can their human rights and culture be adequately respected and protected? All these problems need to be solved urgently.

Not long ago, the prime minister of Tubal's announced that they would relocate to New Zealand to live. However, this is just one consequence of global warming. In order to avoid serious international impact from the environmentally problem, we need to plan ahead.

Human beings are the main culprit in global warming, and human beings should bear the corresponding responsibility and consequences. Can we

allocate responsibility for resettling refugees according to countries' carbon emissions? Can we take effective steps to protect their unique culture? How to make the world willing to accept the resettlement of refugees? We answer these questions by building a series of models.

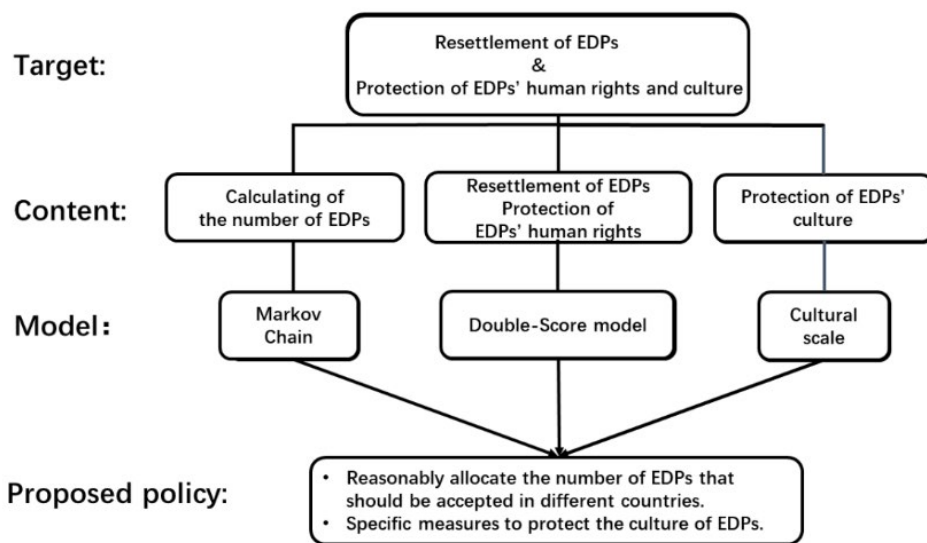The overall idea of this paper is as follows:

Figure 1. Overall idea of this paper

2 Analysis of how many people are at risk of becoming EDPs

Sea levels are beginning to rise at an accelerating rate as the global warming. People living in low-altitude countries are at risk of losing their homes. These people are called environmentally displaced persons (EDPs). How many people are at risk of fleeing their homes now? How many people are likely to become environmentally displaced persons over time by 2100?

Solving this problem requires climatology and demography as well as the theory and knowledge of geography. We obtained the data through the United Nations Statistics Division. An increase in sea level means a decrease in the elevation of low-lying countries. When a country's altitude reaches a certain threshold, its citizens are in danger of becoming EDPs. So we simply think that the height of sea level rise determines the number of people at risk. At the same time, sea level rise is affected by many factors, such as crustal movements and climate change. Many of these factors are random, so we simply treat the sea level as a random variable in this paper. The change in sea level from now to the next year is a random process.

We found that markov chain can solve this problem, so we built a markov model based on markov chain theory. The data obtained above are used to solve the problem, and then the solution results are analyzed.

3 Establish a model to calculate the total number of EDPs

3.1 Assumption

The average elevation of a country determines the country's risk of submergence.

Set 10 meters at the altitude threshold. Countries with an average elevation of less than 10 meters will face flooding.

The number of people currently at risk of becoming EDPs is equal to the total population of the countries below the threshold.

3.2 Model preparation and setup

The long-term change process of sea level can have trended, periodicity and random fluctuation.

We use a simple mathematical model to represent the change in sea level.

$$\triangle L = k * t + b \tag{1}$$

Where k denotes the change trend of sea level height, t denotes the component of trend change, indicating the nature and amplitude of sea level change. b denotes random fluctuation, and L denotes the change height of sea level.

We think of the change in sea level as a random variable. Elevation refers to the vertical distance above sea level of a place, which is directly related

to sea level. Therefore, we regard elevation as a random variable, and the change process of elevation over the years as a random process. The altitude at time T depends only on the altitude at time t-1, not on the altitude at any other time. The change process of altitude satisfies the random process of markov chain model. The conditional probability of altitude complies with the following

relation.

$$P(X_n | X_{n-1}; :::; X_0) = P(X_n | X_{n-1}) X_n (n = 0; 1; 2; 3; :::) \quad (2)$$

Where X_n denotes the value of altitude of the *nth* years.

3.3 Results

To demonstrate better the number of EDPs over time, we drew the following picture.
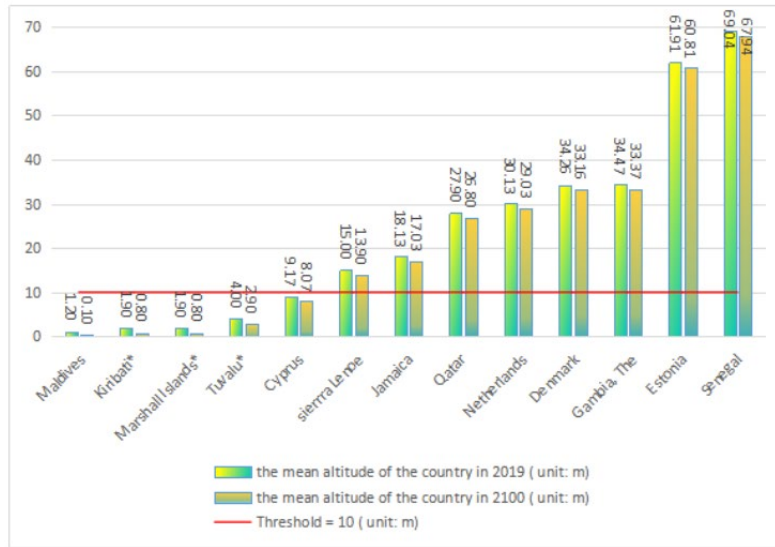

Figure 2. The mean altitude of the country in 2019 and 2100.

Note: The data of altitude comes from Wikipedia. Some of the countries marked with * use the highest altitude instead of the average. Islands with very small populations and small areas are not included, such as the Independent State of Samoa, the Republic of Kiribati and the Republic of Nauru.

"Special Report on the Ocean and Cryosphere in a Changing Climate, SROCC" published by IPCC, which uses the value of 10 meters as the threshold for lower altitudes. We use this as an altitude threshold for

countries with the problems of EDPs.

As showed in the table 1, Kiribat, Maldives, Marshall Island, in 2019, the elevation of Tuval under 10 meters, at risk of submerged. According to the data in table 1, the number of EDPs calculated in 2019 is 7.18996 million.

There is no change in the number of countries below the threshold in 2100. We calculated the sum of the populations of countries below the threshold and calculated the number of EDPs in 2100 at 8.91059 million.

Country	Year 2019	Year 2100
Kiribati	117.606	302.174
Maldives	530.953	453.593
Marshall Islands	58.791	109.527
Tuvalu	11.646	25.765

The data come from United Nations Statistics Division database.

Figure 3. The total national population of Kiribati, Maldives, Marshall Islands and Tuvalu. unit: ten thousand people.

4 Reasonable resettlement of EDPs and protection of their human rights

4.1 Assumption

We used the previous year's carbon emissions data to calculate each country's liability for the EDPs.

We identify countries with high per capita carbon emissions as having high levels of economic

development.

We assume that the major cause of EDPs' loss of homes is carbon emissions, without considering the impact of other factors.

We assume that the policy is absolutely carried out and that there is no non-compliance status.

4.2 Symbol of the model

The sources of Cp and Cw values are from the International Energy Agency. The sources of Cd values are from the United Nations database. The values of Ctd are from a questionnaire survey of EDPs.

Calculation of the value of Clg: By studying the penetration rate of the languages used by EDPs in the countries receiving EDPs, if the language of EDPs is the official language of this country, the probability that EDPs can use their mother tongue in that country is 100%.If no one uses the language of EDPs in this country, the probability is 0%. The higher the penetration rate of the language spoken by EDPs in the country, the higher the probability that EDPs can use the mother tongue in the country.

Symbol	Meaning	Computational Method	Interval
Pco_2	Score of carbon dioxide emission	Cp/Cw * 100	$0 \sim +\infty$
C	Score of suitability for immigration	Cd+ Cj+ Cs + Ctd- Clg - Cld	$-\infty \sim 40$
Cp	The country's per capita carbon dioxide footprint	Query data source	$0 \sim +\infty$
Cw	The world's per capita carbon dioxide emissions	Query data source	$0 \sim +\infty$
Ctl	Carbon dioxide emissions in the country	Query data source	$0 \sim +\infty$
Cwl	Total world carbon dioxide emissions	Query data source	$0 \sim +\infty$
Cd	Sore of the country's level of development	Human Development Index * 10	$0 \sim 10$
Cj	Score of employment outlook	employment rate * 10	$0 \sim 10$
Cs	National security score	(1 - crime rate)* 10	$0 \sim 10$
Ctd	EDPs' immigrant orientation score	Compile the intention questionnaire of EDPs	$0 \sim 10$
Clg	Score of the probability of learning a new language	(1 - Probability that EDPs can use native language in this country) * 5	$0 \sim 5$
Cld	Score of the degree of scarcity of land resources	Population density of the country/global average population density * 10	$0 \sim +\infty$

Figure 4. EDPs Double Score Model

4.3 Double-Scores model OF EDPs

4.3.1 Model Preparation and Setup

After analyzing the problems, we decided to take the Double-Scores model to help us make a reasonable decision to place EDPs. The core of the model is double Scores accounting, but can be one-way compensation. By choosing this model, we can reasonably place EDPs in countries and guarantee the human rights of EDPs. Double scores refers to the degree of immigration scores and carbon dioxide emissions score.

The calculation formula of the two scores is as follows:

$$C = Cd + C j + Cs + Ctd - Clg - Cld \qquad (3)$$
$$Pco2 = a * Cp = Cw + b * Ctl = Cwl \qquad (4)$$

Note: In this formula, a denotes a complex functional relationship between the country's per capita carbon dioxide emission ratio and C, and b denotes a complex functional relationship between the country's total carbon dioxide emission ratio and C. A and b are both

greater than 0.

Global warming is accelerating due to emissions of greenhouse gases such as carbon dioxide, and sea levels are gradually rising. Therefore, we take one country's total CO2 emissions and per capita CO2 emissions as one of the criteria for which countries should bear the resettlement of EDPs. We set the variable Pco2 as the price that each country is required to pay for its own carbon dioxide emissions. By scoring each country, we confirm the responsibility of each country to the resettlement of EDPs. The greater the value of Pco2, the greater the country's obligation.

Objectively, by quantitatively measuring factors such as the degree of development, security and employment prospects of a country, it can be initially determined whether the country is appropriate for receiving EDPs. Subjectively, the immigration tendency of EDPs affects their immigration decisions and happiness in future life. Combining objective and subjective dimensions, we set the variable C to evaluate the optimal immigrant

country.

We set a threshold N for Pco2. When the value of Pco2 in a country exceeds the threshold N, the country is required to bear the responsibility for the resettlement of EDPs. After receiving the corresponding number of EDPs, the value of the country's Pco2 will also decrease accordingly. The more suitable a country is for immigration, the greater the value of C. In order to encourage states suitable for immigration to accept EDPs, we have taken the C value into consideration. When the Pco2 value is equal, the higher the country's C value, the fewer the number of EDPs it needs to accept.

When a country receives refugees, the country's Pco2 value drops to:

$$NewPco2 = a*Cp = Cw + b*Ctl = Cwl + F(C) \quad (5)$$

However, some countries have refused to accept refugees for reasons such as cost-benefit principles and cultural differences. With this in mind, we have given these countries the option to accept refugees or provide economic compensation for EDPs. The amounts paid by these countries will be distributed to countries that receive additional EDPs as resettlement fee and financial assistance.

4.3.2 The relationship between the two indicators and immigration policy

Factors such as the degree of national security, employment prospects, land resources, and the migration tendency of EDPs affect the degree to which a country is suitable for migration. The carbon dioxide emissions of each country affect the responsibility of each country to place EDPs. Data of C and Pco2 jointly determine the formulation of the policy for the resettlement of EDPs.
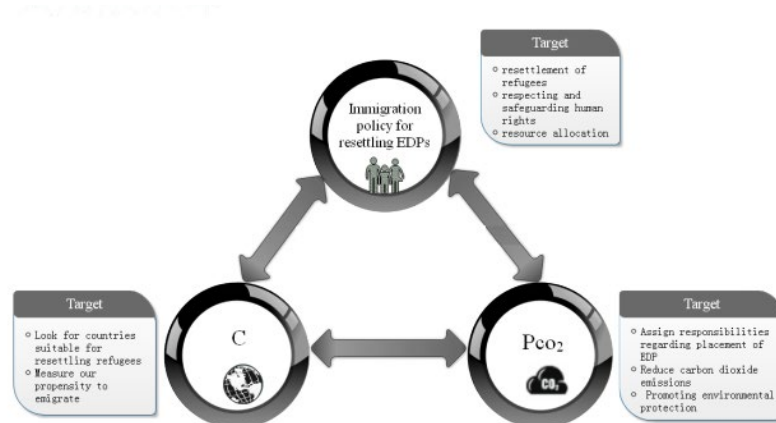

Figure 5. Relationship and Targets

5 Conclusion

We found that markov chain can solve this problem, so we built a markov model based on markov chain theory. The data obtained above are used to solve the problem, and then the solution results are analyzed.

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