Research on the Natural Migration Model Under Climate Change

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Abstract: Excessive greenhouse gas emissions cause global warming. Furthermore, the rise of sea levels will lead to more severe problems, even disappearance of a country. People who become homeless due to climate change events are called environmentally displaced persons (EDPs). They need to relocate, at the the same time, we are obliged to propose related policies in order to protect EDPs human rights, customs and culture. Therefore, we build a complete migration model which includes the maximum distance model for relocation, a choice model to research which countries EDPs are willing to move in and cultural loss model during the migration phase that can help us know the risk of loss of culture. Besides, compared natural migration to migration with UN intervention, we analyse the influences by proposed policy and find the rate of culture loss will reduce under UN intervention.

1. Introduction

Excessive greenhouse gas emissions cause global warming. The reason why glaciers to melt is that temperature rises. Furthermore, the rise of sea levels will lead to more severe problems. For example, The Maldives, Tuvalu, Kiribati, and The Marshall Islands are predicted to be at risk of completely disappearing. People who become homeless due to climate change events are called environmentally displaced persons (EDPs). They need to relocate, but there is also risk of losing a unique culture, language, and way of life. Besides, resettling EDPs should meet three principles: protecting human rights, individual choice considerate national-state responsibility. There are too many complex problems that should be thought. As a result, UN decide open the door to the practical recognition of EDPs as refugees, and propose suitable policies to alleviate this problem.

2. Maximum Migration Radius Model

There is no doubt that each culture has its unique value. As we all know, the process of migration must be accompanied by cultural loss, so we start by analyzing the factors that affect the loss of culture and establish a set of models to study the loss of culture during the EDP migration process without the intervention of the United Nations.

From the predicted national risk coefficient, we know that in year x, y people who have become EDPs will be forced to relocate. What we need to pay attention to is that the population with higher capital strength (called REDP) and the population with weaker capital strength (called LEDP) will autonomously move to a new place, however, their scope of autonomous migration is different. The question of how these two groups of people will move without policy intervention and in which countries they will move should be figured out.

At the first step, the maximum migration radius model for relocation is established. Related variables are as follows:

The maximum migration radius of the poor and the rich is called R_f and R_q. Disposable transportation fee per month the poor and the rich have is called r_f and r_q. Proportion of Annual National Transportation Expenditure to Total Annual Consumption Expenditure is called t. Coefficient of Variation in Special Period is called c. Total Population in a certain country is called P.National Annual Total Income is called a.Poverty Coefficient is called φ.

The formulas are as follows:

$$r_f = \frac{a\varphi t(1-c)}{12P} \quad ; \quad r_q = \frac{a(1-\varphi)t(1-c)}{12P}$$

Assume that flight prices for external traffic routes are $cp_1,cp_2\cdots cp_i$. fares for passenger ships are $cs_1,cs_2\cdots cs_j$. Then multiplying the fare by the transportation distance of the unit price of the flight *ep* and ship *es*. Choose the biggest number as the result of maximum distance of migration.In this way, R_f and R_q can be calculated by the following formula.

$$LEDP: R_f = max\left[\frac{max(cp_i)}{ep}, \frac{max(cs_j)}{es}\right], \quad cp < r_f; \quad cs_j < r_f$$

$$REDP: R_q = max\left[\frac{max(cp_i)}{ep}, \frac{max(cs_j)}{es}\right], \quad cp < r_q; \quad cs_j < r_q$$

Substitute the data of Maldives to solve Rf and Rq. The result are: R_f = 3500*km*,R_q = 3700*km.*

And make a circle with the obtained maximum migration radius. The countries included in the circle are the destination countries that EDP chooses to go to. It was found that although Rf and Rq had a certain difference, the countries included in the range were roughly the same, so the average number 3600 was taken. This radius is used as the migration range of the Maldives EDP without policy intervention.

3. Cultural Similarity Degree Model

At the second step, we establish another model to research which countries EDPs are willing to move in, we call it cultural similarity degree model.

First of all, from the available data, the choice of destinations during population migration is mainly based on cultural similarity. We use the method of gray correlation degree to quantify various cultural-related influence factors by establishing formulas and grading methods, to solve the gray correlation degree, and to calculate the cultural correlation degree between immigration countries and emigration countries,which can also be called cultural similarity degree. Countries with large cultural similarities are targeted for immigration.

A detailed description of the quantitative factors are as follows:

Language: Establish a language similarity matrix L_{ij} for the six major languages in the world, namely, the Austronesian, Indo-European, Niger-Congo, Altaic, Sino-Tibetan, and Asian-African languages. SimL is the similarity between every two language systems.

$$L_{ij} = simL_{ij} \quad i,j = 1\cdots 6$$

Climate: Establish a climate scoring model based on regional precipitation and annual average temperature.

Total Score:

$$Stotal = Sj + Sw$$

Next, we use the above four factors(Language, Region, Traditional, Festivals Climate) to calculate the gray correlation coefficient of the alternative countries. The following steps are the computational process of gray correlation coefficient.

Determine the reference sequence M that reflects the cultural characteristics of EDP

$$M = m_i = (m_1,m_2,m_3,m_4) i = 1,\cdots,4$$

m_i is the score of the corresponding factors of the emigration country according to the above-mentioned cultural quantitative rules.

Then, we determine the comparison matrix B consisting of the cultural characteristics of the k target immigrants.

$$B = b_{ki} = \begin{bmatrix} b_{11} & \cdots & b_{14} \\ \vdots & & \vdots \\ b_{k1} & \cdots & b_{k4} \end{bmatrix}, \quad k = 1, \cdots, n$$

Because the physical meaning of each factor in the model is different, the dimensions of the data are not necessarily the same, which is not easy to compare. Therefore, the reference sequence and comparison matrix are processed by nondimensionalization. Get new comparison matrix *C:*

$$C_{ki} = \frac{b_{ki}}{m_i}, \quad C = C_{ki}$$

Find the grey correlation coefficient between reference and comparison Δ_{ki}. For the reference sequence M and comparison matrix B, we calculate the correlation coefficients λ of M and B at various times. Among them, ω is the resolution coefficient, and its value is 0.5. We note the difference between each factor and the reference value as

$$\Delta_{k_i} = |m_i - C_{ki}|$$

The comparison matrix and the reference number series have an association coefficient for each influencing factor, and the information is too scattered for overall comparison. Therefore, it is necessary to centralize the correlation coefficients of all influencing factors into one value. We take the average value as the expression of the correlation between the comparison matrix and the reference matrix.

$$r_k = \frac{1}{4}\sum_{i=1}^{4} \lambda_{k_i}$$

Note: r_k is the gray correlation between the comparison matrix *B* and the reference sequence M. The closer the r_k value is to 1, the better the correlation between the migrating factor matrix and the migrating factor matrix, that is, the higher the similarity of cultural factors. Using the cultural similarity to represent it.

By calculating grey correlation coefficient, the culture similarity degrees of Maldives and the other 10 countries are shown in figure 1.

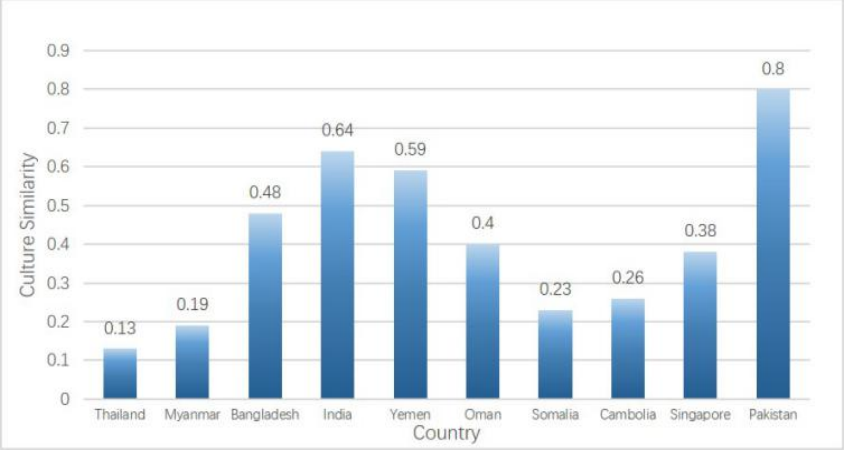

Figure 1. Result of distribution simulation

4. Model of Cultural Loss During the Migration Phase

In this step, we build a model of cultural loss during the migration phase.

• The number of refugees to the target country d_k

Firstly, We only select countries with cultural similarities greater than 50% for relocation, and consider these countries cultural similarities greater than 50% as i_k,k = 1,⋯ n) The poplation of immigration countries is ¶ . The number of refugees to the target country is d_k. Then d_k c an be calculated by the following formula.

$$d_k = \frac{i_k P}{\sum_{k=1}^{n} i_k}$$

• Macroscopic Population Concerntration G_{mac}

After moving out, people who move into the same country are considered to be gathered,compared to the original accumulation amount P^2, there is now$\sum_{k=1}^{n}(d_k)^2$,and the formula of Macroscopic Population Concerntration G_{mac} is easy to obtain:

$$G_{mac} = \frac{\sum_{k=1}^{n}(d_k)^2}{P}$$

• Cultual Loss Proportion in Each Country L_k

The obtained macroscopic population concerntration is understood as the proportion of the national culture's overall retention before settling, then defining L = 1−G_{mac} as the proportion of the national cultural total loss.

As far as the groups moving into country k are concerned, their cultural loss proportion L_k is based on L but differs depending on the size of d_k. For groups with a smaller d_k, it is more difficult for them to maintain their own culture, so their proportion of cultural loss L_k will be larger. Therefore, the following formula is established:

$$L_k = 1 - G_{mac}\left(1 + \frac{d_k - \bar{d}_k}{P}\right)$$

• The Total Amount of Cultural Loss S_k

Finally, the total amount of cultural loss S_k = d_k ∗L_k, and the above four formulas are combined to get the final formula as follows.

$$S_k = d_k * L_k = \frac{i_k * P}{\sum_{k=1}^{n} i_k}\left[1 - \frac{\sum_{k=1}^{n} {i_k}^2}{\sum_{k=1}^{n} i_k}\left(1 - \frac{1}{k} + \frac{i_k}{\sum_{k=1}^{n} i_k} i_k\right)\right]$$

By taking the total population of 500 people as migrants, the amount of cultural loss S_k calculated by the formula is 51.062, 49.532, and 53.144, for people who moved to India, Yemen, and Pakistan respectivel. The overall cultural loss rate is L = 30.74% .

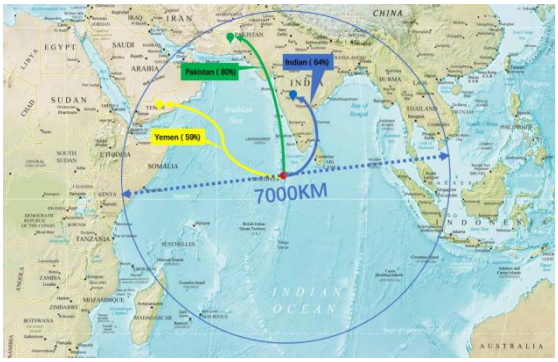

Figure 2. Maldives's Migration Model

5. Conclusion

In this paper, we build a complete migration model which includes three detailed branch models and a specific optimized model about the consideration of cultural assimilation problem. Besides, compared natural migration to migration with UN intervention, we analyse the influences by proposed policy and calculate the rate of culture loss under two different migration methods.

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