The balance between EDPs placement and culture protection

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Abstract. Global climate change has created an increasing number of environmentally displaced people (EDPs). As for the placement of EDPs, we analyze the problem from two aspects. On the one hand, we calculate the number of persons who may become EDPs. We build the EDPs Prediction Model Based on RBF Neural Network to predict the number of EDPs in some countries along the Pacific coast in 5 years. The results demonstrate that Maldives will have the largest number of EDPs, about 9,758 and Australia will have the smallest number, about 873. On the other hand, we analyze the national ability to resettle EDPs. We choose a number of countries with different economic conditions and cultural backgrounds, and analyzed their Receiving Capabilities, Receiving Pressure of EDPs and Crisis Tolerance to provide a basis for placement of EDPs. For the resettlement formulation of policies for EDPs, we first design the Network Flow Migration Model. Then, we optimize the impact coefficient of EDPs on culture, and give EDPs distribution policies in some countries. Considering the personal choices, migration situation and culture beliefs of EDPs, we use the Multi-Objective Optimization Equation to optimize the network flow model. Finally, we propose the policies to resettle EDPs and protect culture according to the risk of culture loss and the resettlement ability of different countries.

1. Introduction
"Environmental refugees" have been mentioned since 1940. Since 1970, environmental damage caused by various developments has caused people to be displaced. The United Nations Environmental Protection Agency (UNUP) and the United Nations Refugee Agency (UNIIRC) have begun to pay attention to this issue together. In 1985, El-limmawi defined “environmental refugees” in the United Nations Environmental Protection Agency’s literature: due to significant environmental damage (including natural and man-made disasters) that hindered their survival and/or seriously affected the quality of life, people were forced to temporarily or permanently Moved away from its original residence. In 1988 Jacobson also emphasized three situations of temporary "displacement" of environmental refugees: regional disasters such as earthquakes and snow (landslides); environmental problems affecting livelihoods and health; and land desertification. In the 21st century, environmental refugees have become mainstream refugees, exceeding the number of traditional refugees. According
to statistics from relevant organizations, there are currently at least 25 million “environmental refugees” who have left their homes in the world. The number of "environmental refugees" will reach 500 million by 2010, and 1.5 billion by 2050[1].

2. RBF-prediction model -- predict the number of EDPs

2.1. Modeling ideas
After investigation, the impact of sea level rise on a country is mainly reflected in the economy, population, land area and residents' happiness. In order to quantitatively measure the above four influencing factors, we use the Gini index, the country's population, the area of the country, and the total national happiness to measure the above four factors.

2.2. EDPs changes as climate increases
We take the following five parameters as training data, that is Gini coefficient, GNH, national population, national land area and the number of EDPs, which are under the influence of climate change in the Pacific coast during the past five years. The learning speed of the primal BP neural network is fixed. Therefore, BP algorithm takes a long time and may fall into the phenomenon of local optimal solution[2].

Between the hidden nodes of RBF neural network we take the distance between input mode and center vector as function argument. Quickly use radial basis functions as an activation function. Hence, we choose the BP neural network optimized by RBF to achieve the weight convergence much faster and more accurately. The network topology of the model is shown in Figure 1.

![Figure 1. Topological structure of RBF.](image)

In Figure 1, $x_1, x_2, ..., x_4$ the four factors affecting the number of EDPs, $y_1, y_2, ..., y_r$ are the number of EDPs. $\alpha_m(x)$ the link function of the hidden layer the number of neurons in each layer is $n_1, n_2, n_3$.

About activation functions of radial basis neural networks.

$$R(x_p - c_i) = \exp\left(-\frac{1}{2\sigma^2}\|x_p - c_i\|^2\right)$$

$y_i$ output of radial basis networks.

$$y_i = \sum_{j=1}^{n_i} \omega_{ij} \exp\left(-\frac{1}{2\sigma^2}\|x_p - c_j\|^2\right)\quad j = 1, 2, ..., n$$

Loss function of least squares method.
\[ \sigma = \frac{1}{p} \sum_{j} \| d_j - y_j - c_j \|^2 \]

2.3. Model calculation and result analysis

EDPs population due to climate change in some countries. EDPs Population and Distribution are shown in Figure 2.

The results obtained by using MATLAB to run the neural network algorithm are shown in the figure. Countries such as Australia, which are less affected by rising sea levels, are expected to produce 873 environmentally displaced people in five years; Countries such as Maldives, which are more severely affected by sea level, are expected to have 9,758 environmentally displaced people.

3. National reception model based on the crisis of EDPs

3.1. Modeling ideas

In recent years, great changes are affecting the production and livelihood of the original inhabitants of coastal countries, forcing some of them to migrate to other countries. Based on our survey, we chose nine typical countries along the coasts of the Pacific and Indian Oceans. The results are shown in Table 1.

| Country | NZL | AUS | IND | SGP | FJI | KAZ | PHZ | VNM | JPN |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1       | 0.082 | 0.096 | 0.196 | 0.097 | 0.181 | 0.143 | 0.002 | 0.134 | 0.087 |

The pressure index is the relative pressure index. By the analysis of the results we can conclude that the India, Fiji, Kazakhstan and other countries have greater receiving pressure. However, the Philippines, which is also less developed, receives less pressure. That is because the Philippines itself is currently affected by rising sea levels.
3.3. The measure of the capability of EDPs receiving countries

Similar to the pressure of EDPs receiving countries, the capability of EDPs receiving countries is mainly affected by five factors: economy, culture, environment, total population and land area. These factors have different impacts on capability in different countries. Therefore, land area is a key factor in measuring its capability. We construct the ability index $I_i$ to measure the capability of EDPs receiving countries.

$G_i$ is the GDP per capita of the $i$th EDPs receiving country, $C_i$ is the change rate of foreign population migration. $\omega_1, \omega_2, \omega_3, \omega_4, \omega_5 > 0$, $\omega_1 + \omega_2 + \omega_3 + \omega_4 + \omega_5 = 1$. Assign weights to above five index. The weights are $(\omega_2, \omega_3, \omega_4, \omega_5) = (0.4794, 0.1063, 0.2579, 0.0359, 0.1205)$. Plug in the data to calculate the capability of nine countries. The capability of nine countries is shown in Table 3.

| Country | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---------|---|---|---|---|---|---|---|---|---|
| India   | 0.1289 | 0.1369 | 0.0927 | 0.1339 | 0.1203 | 0.0827 | 0.0849 | 0.0922 | 0.1275 |

India, Fiji and Kazakhstan have more pollution. As the chart below shows: Despite its high pressure, it has very little capacity. In the long run, they can't afford more EDP. As a result, some countries are more environmentally critical and have a greater impact on global warming, but they cannot afford more EDPs to take on the task.

3.4. The measure of the Crisis of EDPs receiving countries

We measure the crisis of EDPs receiving countries to assess the capacity when the number of EDPs reaches or exceeds their capability. The crisis capacity of receiving countries is mainly affected by the economy, population, environment and land area. Because the crisis capacity is mainly controlled by pressure and capability, we use $O_i, I_i$ to calculate the crisis capacity of EDPs receiving countries. The crisis capacity is denoted by $\lambda_i$.

$$\lambda_i = \frac{I_i \sum O_i}{O_i \sum I_i}, i = 1..9$$

If $\lambda_i < 1$, then the EDPs receiving country’s receiving pressure is less than the receiving capability. It shows that the country is stable. If $\lambda_i > 1$ then the EDPs receiving country’s receiving pressure is greater than the receiving capability. This suggests incompetence and a crisis of acceptance. Substitute the pressure value and capability value of each country into above formula to calculate the crisis capacity of EDPs receiving countries. The crisis index is listed in Table 4.

| Country | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---------|---|---|---|---|---|---|---|---|---|
| New Zealand | 0.7090 | 19.61 | 0.8178 | 3.1276 | 2.648 | 15.46 | 15.46 | 3.85 | 18.35 |

As shown in the table: New Zealand, Australia, Singapore have greater crisis capacity cause they have greater receiving pressure and receiving capability. However, India, Fiji, Kazakhstan, Vietnam have greater receiving pressure and less receiving capability. So they have less crisis capacity. Moreover, Japan, Philippines are affected by climate warming, they have less crisis capacity.

3.5. Model calculation and result analysis

In this model, we calculate the pressure index, capacity index and crisis capacity index of EDPs receiving countries. We can see that for some developed countries, the pressure index is smaller, the capacity index is larger and the crisis capacity index is larger. For some less developed countries, although the capacity index and the crisis capacity index are small, their pressure index is not small. The relationship of measurement index are shown in Figure 3.
For the sake of long-term global development, the United Nations and the more economically developed countries can provide some help to those countries that are less able to withstand crises and have lower receiving capacity, but can receive pressure. Under the overall planning of the United Nations, dangerous countries can be appropriately directed Migration of more developed economies.

4. Analysis on the impact on culture of EDPs

4.1. Culture shock model of receiving country

The migration of EDPs will affect the culture of some Fijian residents. Let the ratio of the number of EDPs to the total population of Fiji be γ. Meanwhile, Fiji residents also affect some EDPs. Let the proportion of Fiji residents to total EDPs be ξ. Thus, the number of people affected by EDPs in the ith year is

\[ m_i = \gamma(1-\gamma)G_0 - \xi(1-\xi)G_i \]  

(1)

G0 is the total population of Fiji, G1 is the number of EDPs moved in. We know the total population affected by the EDPs is G.

\[ G = G_0 + m \]  

(2)

Let the cultural shock of EDP coefficient be β, we use β to reflect the impact of EDPs on Fiji culture.

\[ \beta = \frac{dG}{dt} \]  

(3)

4.2. Model calculation and result analysis

When the input value of EDPs from Kiribati to Fiji is about 2000, let γ = 0.01, ξ = 0.02. So substitute the value of γ, ξ into the model, we get the change rate of cultural shock coefficient ten years after EDPs arrived in Fiji. Change rate of cultural shock coefficient is shown in Figure 4.

It shows that at this time EDPs not only did not impact the culture of Fiji, but even contributed to the development of Fiji culture.

5. Multi-objective optimized network flow model -- assign EDPs

5.1. Establishment of the migration network flow model of EDPs

Step1: Determine the Initial Flow Direction of the Model

During the EDPs migration to nine countries, human rights are protected as much as possible at the beginning. EDPs were free to choose own destination. This creates a situation where the receiving...
pressure does not match the receiving capacity of the EDPs receiving countries in Model 2. Therefore, the receiving countries will have reception crisis. In model 2, we define the crisis capacity of EDPs receiving countries as λ1 Assume that the λ1 of a country is greater than 1, this country only receives the numbers of EDPs within its receiving capacity. The remaining EDPs that should be distributed under its receiving pressure migrate to the other receiving country where λ1 is less than 1. The migration will not be interrupted until λ1 is optimal of the nine receiving countries.

**Step 2: Build the Migration Target of EDPs Programming Equation**

According to calculations, Maldives generates approximately 9758 EDPs and previous nine countries can receive approximately 50,000 EDPs. Considering the personal choices, migration situation and culture beliefs of EDPs, the receiving capacity varies from country to country. Thus, we define certain constraint conditions.

1) Assign 9758 EDPs to previous nine countries.
2) The receiving pressure in each country is less than its receiving capacity. When choosing a migration destination freely, EDPs will choose different countries according to their own reasons, but the receptions of nine countries are much larger than the numbers of EDPs. The objective function are:

1) Under the condition that the receiving capacity of each country is greater than or equal to the receiving pressure, the sum of the cultural shock of EDPs coefficients β to each receiving country is minimized.

2) Under the condition that the receiving capacity of each country is greater than or equal to the receiving pressure, the sum of the values of reception crisis metric of the nine countries has reached a minimum.

Constraints are:

\[
\begin{align*}
\text{Min} \beta &= \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6 + \beta_7 + \beta_8 + \beta_9 \\
\text{Min} \lambda &= \lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6 + \lambda_7 + \lambda_8 + \lambda_9 \\
X_i &\leq P_i, (i = 1, 2, 3...9) \\
\sum_{i=1}^{9} q_i &= 9758
\end{align*}
\]

5.2. Model calculation and result analysis

When assigning relocation routes, taking into account the wishes of the EDPs and the reception situation in the receiving country. The reception situation of the previous nine countries is shown in Table 5.

**Table 5. EDPs staffing.**

| Country | NZL | AUS | IND | SGP | FJI | KAZ | PHL | VNM | JPN |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| EDPs    | 800 | 1395| 707 | 1912| 1766| 636 | 848 | 387 | 1307|

The table shows the reception of EDPs in these 9 countries. Different economies and cultures lead to vastly different results.

**Figure 5. EDPs migration.**
In figure 5 shows the migration situation of EDPs for these nine countries, and visually shows the direction of migration of EDPs. At the same time, the results obtained by the model are consistent with the actual, so it validates the effectiveness of the policy.

6. Conclusions
According to our models, we mainly analyze from the two aspects of personnel placement and cultural protection. In terms of personnel placement, we first classify the impact of sea level rise on coastal countries into four elements: economy, population, happiness, national land. Meanwhile, we use Gini coefficient, gross national happiness (GNP), national population, and land area to measure the above four factors. Then, we analyze the reception pressure, national capacity, and crisis tolerance of different countries. Finally, we conclude that the country’s receiving capacity and receiving pressure are not positively correlated, and that countries with severe environmental pollution are not capable of bearing more EDPs. In terms of cultural protection, we predict the change of the cultural shock of receiving countries. The EDPs have an impact on the culture of the receiving countries when they first move into the countries. But over time, the residents in receiving countries will be less affected or even positively affected. For the distribution of EDPs, first of all, considering the personal choices, migration situation and culture beliefs of EDPs, we propose corresponding policies based on the previous analysis. Then, we calculate the risk of culture shock in the receiving countries of EDPs, and optimize the policies. Meanwhile, we build the network flow migration model. Finally, we use the multi-objective optimization equation to optimize the network flow model and get the final distribution policies.

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