The Establishment of National Vulnerability Assessment System under Climate Impact

Han Su, Wenjing Li, Peilei Zhang, Shanshan Qi, Yunshi Cao
School of Shandong University of Science and Technology, Qingdao, China

Abstract. The effects of Climate Change, to include increased droughts, changing animal and plant ranges, and sea level rise, vary from region to region. Many of these effects will alter the national vulnerability. Internationally, we need to set up an evaluation system to characterize the impact of climate on national vulnerability. We identify four elements of the climatic element: precipitation variability, temperature variance, CCPI, natural disasters. We use AHP to set up an evaluation system to identify the direct and indirect impacts of climate. Besides, the degree of vulnerability of a country is automatically identified through neural network mechanism. We use SPSS software to test the model. 178 groups of regression data are obtained from the model and FFP, and the correlation coefficients are 0.95. We apply the model NVS/CNVS to Afghanistan and China. By comparing the two results, we conclude that climate has reduced the vulnerability of Afghanistan by 1.4 percentage points. For China, in considering climate factors, the vulnerability is significantly reduced by 13 percentage points. Finally, we put forward policies and countermeasures for every country to mitigate the impact of climate change on vulnerability.

Keywords. AHP, national vulnerability assessment system, neural network, Climate Indicators

1. Introduction
Climate change has increased national vulnerabilities and environmental pressures have exacerbated the deterioration of national conditions. The Intergovernmental Panel on Climate Change suggests that the net damage costs of climate change are likely to be significant. Many of these effects will alter the way humans live and may have the potential to cause the weakening and breakdown of social and governmental structures. [1] It is particularly important to build an evaluation system to evaluate the national vulnerability, which needs to reflect the impact of climate.

At present, there is still a lack of accurate evaluation system of national vulnerability under climate impact. We need to develop a national vulnerability assessment indicator and reflect the impact of climate change, and the indicator is applicable to countries of different vulnerabilities. And it also reflects how climate affects national vulnerabilities both directly and indirectly. Last, we explore how countries can intervene to reduce the impact of climate on vulnerability and assess the costs of state intervention.
2. Data Analysis and Preprocessing

2.1. Data Analysis

For climate data, in order to more fully characterize the climate, we have selected four aspects of the climate, including precipitation variability, temperature variance, CCPI and major natural disasters.

Among them, the variance of precipitation is the degree of deviation of precipitation in each country in the past 17 years. The temperature variance is the 17-year temperature deviation of each country, which reflects the high temperature and cold climate impact. CCPI, the Climate change Performance Index is an instrument designed to enhance transparency in international climate politics. Major natural disasters refer to the increase of drought, the shrinkage of glaciers, the change of the flora and fauna, the rise of the sea level, etc. Through statistical analysis, they are given certain values so that they can be quantified deal with. [2]

![The CCPI maps](image)

2.2. Data preprocessing

According to the characteristics of each index reflect the status of vulnerability, select different standardization formula for index standardization.

(1) Standardization:

The sequence X1, X2…… XN is transformed:

$$y_i = \frac{x_i - \min\{x_j\}}{\max\{x_j\} - \min\{x_j\}}$$ (1)

The new sequence y1, y2, …yn [0,1] is dimensionless. [3]

(2) processing results:

After the standardized processing of the four variables superimposed, making it an integrated factor - the comprehensive index of climate change, select the 10 national climate change indices as shown in Table1.
Table 1. national climate change index

| country    | precipitation | Temperature | CCPI | natural disaster | Comprehensive Climate index |
|------------|---------------|-------------|------|------------------|----------------------------|
| Argentina  | 0.5           | 0.2         | 0.6  | 0.5              | 1.8                        |
| Australia  | 0.3           | 0.2         | 0.4  | 0.5              | 1.4                        |
| Austria    | 0.8           | 0.2         | 0.6  | 0.95             | 2.55                       |
| Belarus    | 0.9           | 0.3         | 0.5  | 0.9              | 2.6                        |
| Bulgaria   | 0.5           | 0.5         | 0.6  | 0.9              | 2.5                        |
| Canada     | 0.5           | 1           | 0.4  | 0.6              | 2.5                        |
| China      | 0.5           | 0.7         | 0.5  | 0.8              | 2.5                        |
| France     | 0.3           | 0.2         | 0.9  | 0.4              | 1.8                        |
| Hungary    | 0.5           | 0.3         | 0.7  | 0.8              | 2.3                        |
| India      | 1             | 0.6         | 0.7  | 1                | 3.3                        |

3. Method

3.1. National Vulnerability Evaluation System Based on AHP

3.1.1. The Foundation of Model. National vulnerability is a comprehensive embodiment of national security vulnerability, economic vulnerability, political vulnerability and social vulnerability. We adopt system analysis method and comprehensive index evaluation method, which identified from four aspects of security, economy, politics and society. We constructed the national vulnerability comprehensive measure index system and determined the measure standard value.

This article vulnerability index system of the country is divided into three layers: Target layer, Standard layer and Indicator layer. [5] The target layer is the highest layer and represents the overall goal of the country's vulnerability performance, what is obtained is a comprehensive measure of national vulnerability. The guideline layer is located at the second layer of the indicator system and is composed of four subsystems. The indicator layer is the refinement of the guideline layer and the depth evaluation of the guideline layer. Specific structure as shown below:

(1) Build a hierarchical analysis char
Construct judgment matrix

Construct judgment matrix takes 1 to 9 and its reciprocal as a scale.

3.1.2. Fusion climate factors. There are two ways in which climate impacts national vulnerabilities. One is that climate factors have a direct impact on national vulnerability and the other factors that influence climate change can affect the country's vulnerability by affecting 12 level-1 indicators. Below we discuss separately.

1. The climate has a direct impact on national vulnerabilities—-CNVS1

Using AHP, considering that climate has a direct impact on national vulnerabilities, there are five indicators that judge national vulnerability: security vulnerability, economic vulnerability, political vulnerability, social vulnerability and climate vulnerability. Climate vulnerability includes temperature, precipitation, CCPI and major disasters. Based on the mathematical models that have been developed to assess national vulnerabilities, if climate has a direct impact on national vulnerabilities then we can simply add the indicator of climate vulnerability.

(1) First-level indicators affecting national vulnerability

Table 2. Level 1 indicator weight

| Vulnerability | Safety   | Economic | Political | Society | Climate |
|---------------|----------|----------|-----------|---------|---------|
|               | 0.4378   | 0.2852   | 0.0722    | 0.0372  | 0.1677  |

(2) Secondary indicators of climate vulnerability

Table 3. Climate vulnerability indicators and weights

| Climate | Temperature | Precipitation | CCPI | Major disaster |
|---------|-------------|---------------|------|----------------|
| W       | 0.2622      | 0.1175        | 0.5650 | 0.0553         |

Combined with the first model, the new comprehensive treatment of the indicators and their weight of the national vulnerability.
The function of assessing national vulnerability is:

\[ Y_1 = 0.113x_1 + 0.045x_2 + 0.278x_3 + 0.182x_4 + 0.073x_5 + 0.029x_6 + 0.009x_7 + 0.017x_8 + 0.003x_9 + 0.0043 \\
\quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \qua

2. Climate indirectly affects national vulnerability——CNVS2

If climate indirectly affects national vulnerabilities, then climate factors affect national vulnerabilities by affecting 12 factors such as Security Apparatus, Factionalized Elites and so on. In combination with the model we have come to evaluate national vulnerabilities, we apply AHP to reintegrate into national vulnerabilities that take climate change into account.

### Table 4. The indicators and their weights

| C1  | C2  | C3  | E1  | E2  | E3  | P1  | P2  | P3  | S1  | S2  | S3  |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0.2385 | 0.1365 | 0.6250 | 0.6250 | 0.2385 | 0.1365 | 0.2383 | 0.6250 | 0.1365 | 0.1365 | 0.02 | 0.011 |

Statistics in the safety device, and other twelve factors in the national share of the vulnerability. Get a new function expression describing the national vulnerability:

\[ Y_2 = 0.124x_1 + 0.071x_2 + 0.32x_3 + 0.081x_4 + 0.046x_5 + 0.023x_7 + 0.059x_8 + 0.013x_9 + 0.006x_{10} + 0.03x_{11} + 0.011x_{12} \]  

(3)

3.2. **Automatic recognition mechanism based on Neural Network**

We use stratified sampling method randomly selected 20 countries into the model for research, making the selected country more random. The vulnerability assessment indices of the 20 countries that are included in the model are as follows:
According to this indicator, we divide country Y, and then divide the country into fragility countries, vulnerable country vulnerable countries and the stable countries. Classification level is as follows:

| grade      | Y  |
|------------|----|
| stable     | 0-0.3 |
| vulnerable | 0.3-0.7 |
| fragility  | 0.7-1 |

Neural network is a layer feed forward network trained by error inverse propagation algorithm. It is one of the most widely used neural network models. By using neural networks and our existing classification, the country's fragile, fragile and stable classification is automatically identified and applied to multiple countries.

4. Model test and application

4.1. Model test

| Country     | Year | Rank  | Total | NVS Y1 |
|------------|------|-------|-------|--------|
| Argentina  | 2017 | 140th | 48.2  | 3.39   |
| Australia  | 2017 | 172nd | 22.3  | 1.97   |
| Belarus    | 2017 | 95th  | 72.4  | 5.01   |
| Bulgaria   | 2017 | 132nd | 53.7  | 3.75   |
| Norway     | 2017 | 177th | 20.5  | 1.79   |
| Poland     | 2017 | 151st | 40.8  | 3.04   |
| Romania    | 2017 | 136th | 50.9  | 4.01   |
| Russia     | 2017 | 67th  | 79.2  | 6.03   |
| Saudi Arabia | 2017 | 101st | 71.2  | 5.15   |
| Turkey     | 2017 | 64th  | 80.8  | 6.34   |

Using SPSS software, the website [6] 178 groups of vulnerability results and evaluation system of the results of regression analysis, the result is as follows,$R^2=0.947$. This shows that the model we set up has higher accuracy, can well assess the national vulnerability Specific results are as follows:
Table 7. ANOVA^a

| Model       | Sum of Squares | df | Mean Square | F       | Sig.  |
|-------------|----------------|----|-------------|---------|-------|
| Regression  | 97292.635      | 1  | 97292.635   | 3167.194| .000b |
| Residual    | 5406.522       | 176| 30.719      |         |       |
| Total       | 102699.158     | 177|             |         |       |

^a. Dependent Variable: TOTAL
b. Predictors: (Constant), Y

4.2. Model application

4.2.1. Afghanistan. In Afghanistan, for example, we surveyed the composite index of climate change in Afghanistan and got the following result.

Table 8. The climate factors are standardized

| CCPI standardization | Temperature variance standardization | Precipitation variance standardization | Major disaster |
|----------------------|--------------------------------------|----------------------------------------|----------------|
| 56.2                 | 7                                    | 5                                      | 9.5            |

As can be seen from the data, its CCPI, temperature variance, precipitation variance and major disaster assessment index are higher, that is, the climate change index is relatively large, that is to say, if we consider the climate factor in Afghanistan, the national vulnerability assessment index is Will rise.

We study the national vulnerability assessment indicators in Afghanistan without considering the impact of climate, the direct impact of climate and the indirect impact of climate on the national vulnerability assessment model, respectively, to find the three countries Vulnerability 8.716, 8.847, 8.76. The impact of climate on the national vulnerability of Afghanistan has been drawn to increase its vulnerability by 1.4 percentage points. From this we can see that, after considering the vulnerability of climate, the national vulnerability of Afghanistan will increase due to the combination of temperature, precipitation, CCPI and natural disasters.

4.2.2. China. We choose China as the country to which our model is applied and collect relevant data. We will bring the data to the model we have established; the results are as follows:

Table 9. China's state

| Do not consider the climate factor is 0.4577 | vulnerable |
|--------------------------------------------|------------|
| Direct impact on climate is 0.6261         | vulnerable |
| Indirect impact on climate is 0.5383       | vulnerable |

We can see from the above table, according to our model under the influence of not considering the climate factors, China is divided into vulnerable countries. The state of the country, though considered climate-affected, is classified as vulnerable, the vulnerability is clearly declining. At the same time according to the above table, we can also see that the intensity of the direct impact of the climate is stronger than the indirect impact.
5. Results and Discussions

In our assessment model, we can see that the impact of climate on national vulnerability is mainly reflected in the four aspects of temperature, precipitation, CCPI and natural disasters. By regulating these four indicators, the state can prevent this country from becoming a "vulnerable country". Through Afghanistan and China, we can clearly see the impact of climate change on national vulnerability. Every country needs to work to improve the climate and weaken this influence.

1. The country's macro-control of the climate
   The impact of temperature changes is mainly manifested in the melting of the glaciers and sea level rise, which in turn lead to flooding and make the country more vulnerable. The countries can take the following measures:
   (1) Reduce greenhouse gas emissions. (2) Actively carry out international exchanges and cooperation, such as convening a climate change conference.

2. National macro-control of precipitation
   The impact of precipitation on national fragility is manifested in drought and flood disasters caused by uneven precipitation, debris flow, landslides and so on, thus affecting the national vulnerability. Specific measures that countries can take to address this issue are:
   (1) Repair reservoir. Relieve drought and flood caused by uneven rainfall; (2) Afforestation. Avoid too much precipitation caused debris flow disaster.

3. National macro-control of CCPI
   Climate change is mainly manifested in the increase of various extreme weather in recent years mainly in extreme weather such as world storms, floods, droughts and harsh heat waves. The state's control measures on CCPI are mainly [7]:
   (1) Implement concrete measures to control greenhouse gas emissions; (2) Energy-saving emission reduction, control of industrial structure; (3) Encourage scientific research and development of new energy sources, and new technologies.

4. National macro-control of natural disasters
   In recent years, frequent natural disasters, natural disasters in different countries and regions are not the same. The frequent occurrence of natural disasters makes the country more vulnerable. In response to this problem, the state can take measures are:
   (1) Establish a system for the pre-monitoring, assessment and forecasting of natural disasters; (2) Establish flood control and drought relief projects, earthquake and earthquake proofing projects;

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