Analysis of the Impact of Climate Change on National Instability

Jincheng Mao

Jilin University of Finance and Economics, Changchun, China

maojinchengwstc@163.com

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Abstract: Climate change has had obvious and far-reaching impacts on the Earth's ecosystems and socioeconomic systems, threatening the living environment of mankind and the sustainable development of society and economy, it might even lead to the weakening and collapse of social and government structures. Countries are also vulnerable to the impact of climate change. Based on the National Instability Index developed by the Peace Foundation, this paper conducts a theoretical study of the relationship between national instability and climate change through statistical analysis.

1. Introduction

"Instability" refers to the degree to which something changes in its nature under random and uncertain factors like mistakes, pressures or accidents. “Instability of a country" on the other hand refers to the instability demonstrated by a sovereign state or country in the face of a natural impact. The higher the Instability of a country is, the worse its stability would be when facing an unexpected situation. As one of the factors that will affect the country, climate change are likely to cost significant net damage change. At the same time, when severe climate change occurs in a country, it will lead to a reduction in the country's ability to cope with its own problems, exacerbate the deterioration of the country's situation and further enhance its instability

2. Problem Analysis

2.1 Restatement of the Problem

The problem needs us to build a mathematical model to describe and classify “National Instability”. Consider and answer the following:

Task 1: Establish a model that can simultaneously measure the impact of national vulnerabilities and climate change. Identify the direct or indirect relationship between climate change and national instability.

Task 2: Identify how climate change affects the country's vulnerability through one of the ten most vulnerable countries identified by the Fragile Country Index.

Task 3: Determine how climate change affects the country's vulnerability through one of the top ten countries ranked by the Fragile Country Index. Find the critical point

2.2 Analysis of the problem

This issue requires us to establish a mathematical model to describe "national vulnerability" and to build the relationship between climate change and "national vulnerability" so as to be able to predict the development trend of countries under the influence of climate to reach the critical value Before that, at the right time, intervening with the state and intervening in the planned development of the country are the steady development of the country. regardless of the country's geographic location and territory. We expects this model to be applicable to a wider range of situations, regardless of the country's geographic location and territory.

In order to achieve the expected effect of the model to achieve the purpose, we constantly improve the model during the modeling process, and continue to verify.

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We first find the intermediate amount between climate change and "national vulnerability", use global data to model it and adapt it to a variety of vulnerabilities and then validate it with one of the ten most vulnerable countries to ensure that the model is reliable.

Second, we need to determine the critical point. For better research, we first analyzed a country that is not on the pinch hour list, then determine the indicators of the critical point and determine when the critical point can be reached.

We searched for more detailed information, put forward turrets that could mitigate the risks posed by climate change through interventions and made cost budgets so that the state could intervene more effectively and in a planned manner.

Finally, we refine the established model by analyzing several regions of different sizes and environments, so as to make the model more adaptable.

2.3 Assumptions

·The 12 indicators of the FSIs system provide a more complete picture of national vulnerabilities.
·Examples in the same cluster are more likely to have the same markup.
·The impact of non-environmental factors on national vulnerability is constant
·Data on temperature and precipitation are assumed to be accurate and unprovoked;
·Temperature and precipitation can represent the climatic conditions.

3. Our Model

3.1 Task One

According to Task I, we need to establish a model to measure the instability of a country, and to determine the impact of climate change on national Instability. The instability of a country can be assessed comprehensively from multiple perspectives, such as politics, economy and resources. According to studies on national instability, specific indicators are often adopted to quantitatively analyze the instability of a country. In this paper, we adopted the 12 indicators, used by the Peace Foundation, to measure the NIF. [1] (12 indicators include C1: Security Apparatus, C2: Factionalized Elites, C3: Group Grievance, E1: Economy, E2: Economic Inequality, E3: Human Flight and Brain Drain, P1: State Legitimacy, P2: Public Services, P3: Human Rights, S1: Demographic Press, S2: Refugees and IDPs, X1: External Intervention). The 12 Indicator Degree calculations ignore the impact of different indicators on the instability of different countries. We on the other hand, evaluate the main components of the vulnerability and build a new system to make a comprehensive evaluation. We named our final result National vulnerability integrated value (the NVIV).

We use the 2006 Global Fragile Index table for our mathematical modeling. At first, the correlation analysis of 12 indicators found that there is a strong correlation between the indicators, therefore, we use of spss data to factor our analysis, By normalizing the original 12 indicators, calculating the correlation coefficient matrix, calculating the eigenvalues and eigenvectors, calculating the load of the principal components and the scores of the principal components, and using spss to factorize the data, the results are shown in Figure 1.

72	Sample Sufficient Kaiser-Meyer- Olkin metric			73	.956
74	Bartlett's Sphere Test	75	Approximate K^2	76	2271.246
		78	df	79	66
		81	Sig.	82	.000

Figure 1 KMO and Bartlett's test

In the table above, KMO value is greater than 0.956, Sig value is smaller than 0, the results of the principal component analysis is valid

Table 1. Component Matrix

	Component		
	1	2	3
C1: Security Apparatus	93 .932	94 .114	95 -.179
C2: Factionalized Elites	97 .908	98 .242	99 -.191
C3: Group Grievance	101 .863	102 .283	103 .093
E1: Economy	105 .827	106-.360	107 .034
E2: Economic Inequality	109 .882	110-.069	111 -.014
E3: Human Flight and Brain Drain	113 .830	114-.334	115 .180
P1: State Legitimacy	117 .948	118 .046	119 -.206
P2: Public Services	121 .919	122-.255	123 -.046
P3: Human Rights	125 .913	126 .110	127 -.289
S1: Demographic Pressures	129 .900	130-.151	131 .108
S2: Refugees and IDPs	133 .772	134 .363	135 .428
X1: External Intervention	137 .860	138 .014	139 .196

Through factor analysis, three principal components were extracted from 12 indicators in the national fragile index table.

Table 2. Component Matrix

	Component		
	1	2	3
C1: Security Apparatus	151 .100	152 .181	153 -.379
C2: Factionalized Elites	155 .097	156 .383	157 -.405
C3: Group Grievance	159 .093	160 .447	161 .197
E1: Economy	163 .089	164-.570	165 .072
E2: Economic Inequality	167 .095	168-.110	169 -.029
E3: Human Flight and Brain Drain	171 .089	172-.528	173 .382
P1: State Legitimacy	175 .102	176 .073	177 -.437
P2: Public Services	179 .099	180-.404	181 -.098
P3: Human Rights	183 .098	184 .175	185 -.613
S1: Demographic Pressures	187 .097	188-.239	189 .230
S2: Refugees and IDPs	191 .083	192 .574	193 .907
X1: External Intervention	195 .092	196 .022	197 .414

The three components are:

$$COM1=0.100*C1+0.097*C2+0.093*C3+0.089*E1+0.095*E2+0.089*E3+0.102*P1+0.099*P2+0.098*P3+0.097*S1+0.083*S2+0.092*X1$$

$$COM2=0.181*C1+0.383*C2+0.447*C3-0.570*E1-0.110*E2-0.528*E3+0.073*P1-0.404*P2+0.175*P3-0.239*S1+0.574*S2+0.022*X1$$

$$COM3=-0.379*C1-0.405*C2+0.197*C3+0.072*E1-0.029*E2+0.382*E3-0.437*P1-0.098*P2-0.613*P3+0.230*S1+0.907*S2+0.414*X1$$

Take the contribution rate of the three main components as the weight respectively, a comprehensive evaluation model of the main components is constructed:

$$M=0.77612COM_1+0.05272COM_2+0.0392COM_3$$

In order to study the relationship between measures and national instabilities, a correlation analysis of the measures and national vulnerability indices was carried out and fitted, and the results are shown in Figure2.

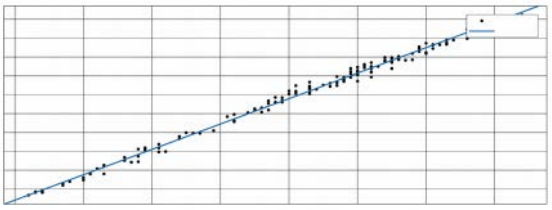

Figure2 Curve fitting

The functional relationship between the NVIV and national instability is:

$$Fs=13.47*m+0.6948$$

Based on the weighted fuzzy C-means clustering algorithm [3], each country's 12 index data clustering analysis of the cluster tree is as shown in Figure3:

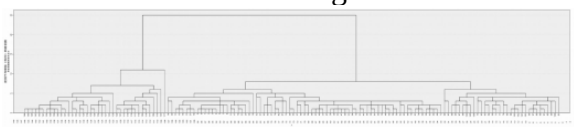

Figure3 Cluster analysis

Figure3 shows that the data can be divided into three categories, each of which contains countries with similar instabilities. Specifically, the first category is numbered 1-67, the second category is numbered 69-109, The three categories of data numbers from 109-146, we numbered the FSI2006 according to the data table, the three categories are included in each country's measurements. [4] We have three sets of measures, respectively. One is greater than 6.7; another is greater than 5.2 and less than 6.7; and the third is less than 5.2. Since the new measurement we set up is used to measure the degree of national vulnerability, we can use the standard measurement as a measure of the vulnerability of a country

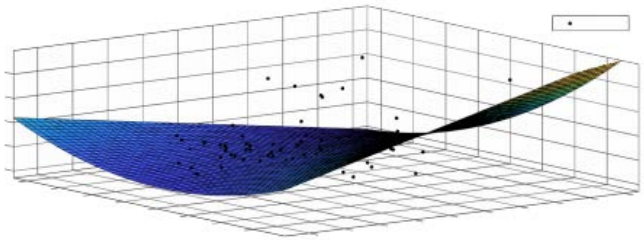

Figure4

Next, we analyze the correlation between temperature and rainfall with 12 indicators. The change of temperature has a negative impact on all countries. Therefore, we can analyze the data sets of multiple countries on temperature. We found that the correlation between temperature and 12 indicators is obvious, and the confidence level is high. Based on the result, we built a regression model between temperatures and measured the values, and the results are as followed:

$$m=0.7845*t^2-0.8151*t*r+0.0312*r^2-1.471*t+0.3795*r-0.5126$$

$$m=m_g-m_i$$

As is shown in the equation, the determination coefficient of this equation is R ^ 2 = 0.9012, so the fitting degree is good. Fitting curves and equations show that when the temperature rises and the precipitation decreases, the comprehensive value of the national instability increases obviously, and the national instability index increases. When the temperature decreases and the precipitation increases, the national comprehensive instability also increases high.

Obviously, this model is consistent with the actual situation. In actual conditions, rising temperatures and declining precipitation will lead to natural disasters such as droughts, resulting in a decrease in cultivated area and economic downturn, as well as an increase in the gap between the rich and the poor and in the continuation of violent conflicts. As a result, the country increases its national instability. [5]

To study how temperature and precipitation affect national vulnerabilities respectively, we adopt the idea of controlling variables. When there is no obvious change in precipitation, the integrated values of temperature and national instability are fitted. The result is shown in Figure4.

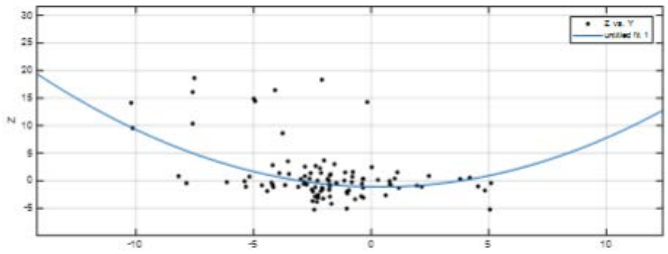

Figure5

At 95% confidence level, the temperature is directly related to the measure, the measure increases 0.106 for every 1 degree increase in temperature, and the measure decreases 0.106 for every 1 degree decrease in temperature. In the meantime, if the measurement can fully reflect the degree of instability of a country, it shows that the temperature change directly affects the change of a country's instability, the temperature increases, and the instability increases. The temperature decreases, and the instability decreases. [6]

In building the relationship between rainfall and national fragility, we consider that different countries tend to have different impacts on the change of rainfall due to their different geographies. For example, the rainfall in arid countries has increased to a certain extent, which obviously affects to crop yields and to reduce population pressures, but out of the basin's countries, excessive precipitation increases that have a negative impact on people's livelihoods and therefore have a combined effect on the instability of a country's rainfall specific country-specific analysis, but also in accordance with the temperature on the regression of regression methods, regression analysis, and then make the judgment of the impact of rainfall on the country's instability.

3.2 Task Two

In resolving Task 2, we select Congo as the research object to analyze how climate change affects its instability. By querying data, we find that the temperature in the Congo from 2006 to 2013 is stable and the temperature difference between adjacent years average volatility value is less than 0.27 degrees Celsius, but the precipitation is very fluctuating, the average annual fluctuations in the value of the difference between the years is 4 mm, in the task of a problem we have proven that the temperature and the national instability between In direct connection with the small change in temperature in the Congo[7], when studying the impact of climate on the country's instability to the Congo, the impact of temperature on the instability of the country can be temporarily neglected, with a focus on analyzing the relationship between precipitation and 12 indicators and thus affecting National Instability.

According to the model established in Question 1, using the data of temperature, precipitation and 12 indicators of the Congo from 2006 to 2013, the composition of the matrix is multiplied by the numerical matrix of 12 indicators to get the composition of the three principal components Score, and then calculate the measure value, the result is as follows:

Table 3. Measure Value

Country	Year	Metric	Component 1	Component 2	Component 3
Congo	2006	8.2	10.4	1.8	1.9
Congo	2007	7.9	10.0	1.1	2.1
Congo	2008	8.0	10.1	0.7	2.4
Congo	2009	8.1	10.3	0.9	2.7
Congo	2010	8.2	10.4	0.8	2.3
Congo	2011	8.1	10.2	0.9	2.2
Congo	2012	8.3	10.5	1.7	1.6
Congo	2013	8.3	10.5	1.7	1.6
Congo	2014	8.3	10.4	2.5	1.7
Congo	2015	8.2	10.4	2.2	1.2

We take the change of rainfall in 2006-2015 as the independent variable and take the change of the comprehensive value of the national vulnerability as the dependent variable. According to the above model, we process the data and draw the following results:

Let the temperature change t = 0, get the functional relationship between the change of precipitation and the variation of the comprehensive value of national vulnerability. [8]

$$m=0.0312*r^2 +0.3795*r-0.5126$$

Residuals calculated by the formula above are analyzed to the real results. The result shows that the residual value is very small, and the result is as predicted in the interval of 95% confidence.

We conclude that there is an inverse relationship between precipitation in the Congo and national vulnerabilities, increased precipitation and reduced national vulnerability

We conclude that there is an inverse relationship between precipitation in the Congo and national instability, increased precipitation, reduced national instability, decreased precipitation and increased national instability.

Next, we analyze what kind of measures will be produced after removing the influence of climate change factors. Firstly, we do a correlation analysis between rainfall and 12 indicators, and then we compare the five indicators c2 c3 e3 p1 p2 p3 Excluding, the remaining indicators of principal component analysis, the composition of the three principal components score coefficient matrix: [9]

Table 4. Component Score Coefficient Matrix

	Component		
	1	2	3
C1: Security Apparatus	0.263	0.518	0.018
E1: Economy	0.297	-0.274	0.491
E2: Economic Inequality	0.252	0.307	-0.731
S1: Demographic Pressures	0.323	-0.099	0.404
X1: External Intervention	-0.158	0.637	0.611

Also, to use the task to build a comprehensive evaluation of the main component model, you can calculate the new component score matrix:

Table 5. New Component Score Coefficient Matrix

Metric	**Component 1**	**Component 2**	**Component 3**
10.2	8.7	11.0	7.5
10.0	8.7	10.8	7.1
10.0	8.9	10.5	7.3
10.2	9.0	10.8	7.2
10.4	9.2	10.8	7.4
10.2	9.1	10.5	7.4
10.2	9.1	10.5	7.9
10.2	9.1	10.5	7.9
9.9	8.5	10.5	7.8
10.0	8.6	10.8	7.4

By comparing the measured values before and after culling, we find that the measured values are significantly higher and the corresponding national vulnerabilities are also significantly increased. The reason for this is that the environment plays a positive role in the DRC and a good environment Contribute to their livelihood development.

3.3 Task Three

According to task three, we choose Vietnam as the analysis object and calculate its measure through the principal component comprehensive evaluation model of task one. The result is as follows:

Table 6. Component Score Coefficient Matrix

Metric	Component 1	Component 2	Component 3
5.8	7.4	0.1	0.2
6.1	7.4	-0.5	9.9
5.8	7.0	-0.4	10.7
5.8	7.3	-0.6	4.9
5.2	6.6	-0.8	1.9
5.2	6.6	-0.2	1.7
5.0	6.4	-0.4	1.3
5.0	6.4	-0.1	1.3

We calculate the average of its measures to get:

$$(5.8 + 6.1 + 5.8 + 5.8 + 5.2 + 5.2 + 5.0) /8=5.5$$

Because 5.2 <5.5 <6.7, we judge that Vietnam is a relatively fragile country, and also perform regression analysis on the precipitation and the measured values. [10]

First, we consider the temperature factor, we use MATLAB to do the temperature changes and the interpolation between the measured values and get the following figure5:

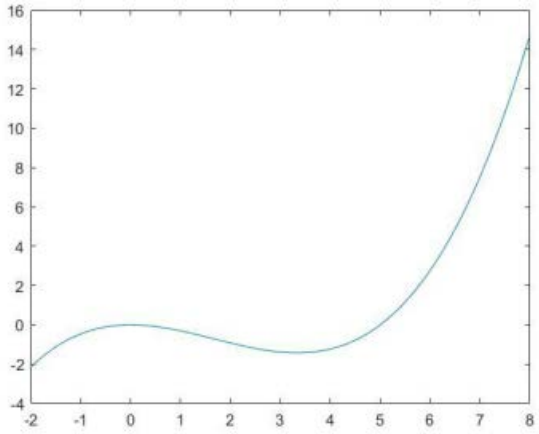

Figure 6

When the temperature changes for less than 3.5 degrees Celsius, the measurement value decreases; when the temperature changes for more than 4.5 degrees Celsius, the temperature changes begin to push Vietnam to become more vulnerable; and as the temperature changes, the changes of the measurements speed up significantly. Similarly, when precipitation changes for more than 48.7 mm, Vietnam starts to become more vulnerable.

In order to better study the impact of climate change on our country, we need to be able to pinpoint a country where it begins to become vulnerable, so we define the cutoff point: Critical point: Climate change conditions that enable a country to cross a node at the level of instability

The model established in 4.1 shows that as the climate changes drastically, the rate of change of the metric change is faster, therefore, the process of national fragility is accelerated. Under three different conditions, various factors work together and the national instability is different under different conditions Under the formation of a relatively stable interval can be maintained, that is, outside the range, the country will be vulnerable until the next one can maintain a relatively stable interval. Near the critical point, there usually will not be such a relatively stable interval. Coupled with the rate of change of measurement changes, often the country will occur in the temporary change of the instability rate of mutation.

Therefore, when a country's instability grows rapidly with climate change that does not conform to the law, it often reaches the country near the critical point

Furthermore, when a country suffers from a huge climate change within a short period of time, that is, when the average temperature in a short period of time increases by about 8.3 ° C and the precipitation increases by about 93 mm, it will also cause state fragility and increase national

economic and financial resources at an extremely high rate, Arable land and so suffered a tremendous impact, leading to the country to reach the critical point.

4. Advantages and Disadvantages

4.1 Advantages

1) It can eliminate the correlation between the evaluation indicators

Because the principal component analysis in the transformation of the original index variables formed mutually independent principal components, and proved that the higher the correlation between the indicators, the better the principal component analysis

2) It can reduce the workload of index selection

For other evaluation methods, it is relatively easy to select the indexes because it is difficult to eliminate the related influence between the evaluation indexes. However, the principal component analysis is relatively easy to select the indexes because it can eliminate the related influence.1. We use this method to ensure that the immediate contribution rate is kept at a high level and that the principal component is related to the actual context and meaning

4.2 Disadvantages

This method has a certain degree of ambiguity than the basic data is clear, because by reducing the number of principal components is less than the number of the original variable.

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