A Climatic Network Model of Region Stability

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Abstract: In recent years, climate issues have caused people's attention. Besides, the Intergovernmental Panel on Climate Change propounds the climate change is important to influence regional instability in 2017. In this paper, we analyze the weights of 12 indexes of a fragile country by using PCA (principal component analysis) and work out our evaluation model. We apply Grey Predicted Model, and we successfully predict the next two time when the flood would occur in September 2020 and in September 2021 in Bangladesh by adding the factor of the disaster index and the precipitation. Finally, We revise our model into a generalized one to suit various regions and bigger continents.

Keywords: The fragility score system; PCA analysis; Predicted model; The generalized model

1. Introduction

Climate change has already had obvious influence on the environment. Problems like be short of water, changing animal and plant ranges would bring about refugee issue, brain drain, violent conflict and so on. At the same time, these effects of climate change may weaken or break-down the governmental structures, which, consequently, could result in fragile states. The climate could be a cause of the fragile states, particularly, when the climate change combines with weak governance and social fragmentation. Take Syria and Yemen as an example, the drought of these two areas exacerbated already fragile states. Because of the drought, the inhabitants there would have little to drink. The pressure on the climate change accelerated the violent conflicts. Therefore, the stability of these countries is still a big challenge to us today.

2. The Establishment of the PCA Model

Determining a country's fragility needs to consider many aspects. We should screen out the main factors so that we use the evaluation model with PCA to determine the fragility.

The fragile states index considers 12 factors to determine the fragility of the 178 sampled countries. The 12 factors are respectively Security Apparatus, Factionalized Elites, Group Grievance, Economy, Economic Inequality, Human Flight and Brain Drain, State Legitimacy, Public Services, Human Rights, Demographic Pressures, Refugees and IDPs, and External Intervention. Developed from the analytic hierarchy process(AHP) , we choose the principal component analysis（PCA） , which is a structured method for statistics to merge the independent data and to get linearly independent components. In that way, we filter the 12 factors from the data of fragile states index. Then, we can safely reach the main causes for the fragile country. Through the Component Matrix, solved by Statistical Product and Service Solutions (SPSS), we integrate 12 data, and work out the three main factors. Part of the calculating result is shown in the Table 1.

Table 1. The top 3 Causes of Fragile States

Causes	Economy	Politics	Infrastructure
Variance percentage	73.744	9.097	4.633
Cumulative percentage	73.744	82.841	87.474

Unsurprisingly, the figure above shows that the most important cause is economy, which is followed by politics and infrastructure. So we use economy to show the degree of the fragility later. After solving our model, the fragility of the three factors can be determined by the formula:

$$F=0.4005E+0.3669P+0.2325i$$

F is the fragility of a country, P is the part of the political liberty, i is the part of the infrastructure.

Based on the formula, economy is the most determining factor of the fragility of a country, after analyzing the degree of the three parts.

3. The Grey Model of Prediction

3.1. The establishment of the model

The grey prediction model has a very good effect on the short time series, low statistical data and incomplete information system analysis and modeling, so that we util-

ize the grey model to solve the prediction part. We utilize our model to Bangladesh which is not on the list of the top 10. When it comes to Bangladesh, the natural disasters are mainly caused by the disaster of floods.

By looking up a lot of data, we found the rainfall of Bangladesh in the month when the flood disasters had been concentrated in the period. To better express our model, we let j=1⋯132 correspond to the 12 months varying from January 2005 to December 2015 They are used as the original data sequence, and we calculated the cumulative sequence. In order to read the table more easily, we choose the second column of the Table.4 to illustrate. It means that the 31th month sees the first flood during the months we choose.

Concluding the folumn above,we find out the range of P and C,and it shows that of our model has a high the predicting degree

$$P \geq 0.95, \quad C < 0.35$$

As a result, it is reliable to use our model to predict the flood. The prediction formula is given as follows.

$$X^{(1)}(k+1)=150.1154e^{0.2192k}-119.1154$$

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3.2. The optimized model

According to the obtained background, we take the specific situation of Bangladesh into account. So we revise the national fragility model given for the first two tasks. We add a new index of the probability of the natural disasters in this optimizing model. We set up a model to measure influence degree of natural disasters and a model of a measure of GDP and the degree of the natural disasters. In order to better explain climate factors caused by natural disasters in Bangladesh, a country which is sensitive to climate change.

Precipitations are included as a natural disaster degree of explanatory variables and the degree of natural disasters as the interpretation of the economic variables. According to such two models above, we adopt the linear regression, the final will we get the economic model of precipitation to the previous evaluation model, in the process of every step for each data standardization process, which can completely rate model, introduced the rainfall of the variables. so the resulting model is

3.3. The factor causing more fragile and the prediction

Based on the data collect until December 2015, we start to predict the time when the flood would occur by continuing to expand the sequence. The output value of our model is 172, 212, and 260 respectively. That is to say, the flood would occur in June, 2017, September, 2020, September, 2021.According to the fragility scoring system, we calculate the score shown in the Table.6 of the year of 2016 and 2017.

Table 2. The Determination Changes of Bangladesh

	Year	Score	Determination
Bang ladesh	2016	36.0949	vulnerable
	2017	50.3531	fragile

The change factor of the two year is the index of the natural disaster, namely the flood. The score is based on the tipping point definition which has been established in our fragility scoring system. At the same time, we also receive when the precipitation index is 0.72, the country will also become fragile.

In conclusion, when it comes to Bangladesh, the factors that influence the country's fragility is the infrastructure, politics, air quality. the sea level, the precipitation index, and the natural disaster index. We also conclude that the country will reach the tipping point when in the September, 2020, September, 2021.

4. The Generalized Model Adapting to a bigger Country

First of all, because the development of the countries in same continent are obviously different, it is necessary for different countries to set a coefficient k to measure the level of economic development in this country. We can

choose different k for different countries. Since climate also affects the economy, it can be assumed that climate indicators are also affected by this factor infrastructure is also relevant to the level of economic development, but facilities are determined by both of the economic and climatic factors, so a t-variable is introduced to describe the level of facilities. In conclusion, the total range of k has two factors. The evaluation of the political system in various countries is very subjective and has gone beyond the technical level. So we will not go into details here. In the end, we can get the following promotion model:

$$F = 15.9487 + 0.3669P + 0.2325it + k(2.8754t_4 + 0.6130t_9)$$

Second, we shrink the model from a country to a city. Although the urban-rural gap, climate and the facilities are not the same in a country, the above model is still available because a country can ignore the political factors. The influence coefficient does not prevent the replacement of two letters, so the promotion model is as follows:

$$F = 15.9487 + 0.3669P + 0.2325ia + b(2.8754t_4 + 0.6130t_9)$$

5 . Conclusions

Our model is adaptive to a country, so when it comes to a city, the situation of it is also the same. Therefore, our model can work on smaller areas. We then do the work to examine whether our model can be applied to a bigger continent. It is successfully adapted to a bigger continent after we devising the model into a generalized model

References

[1] Schwartz, P. and Randall, D. "An Abrupt Climate Change Scenario and Its Implications for United States National Security", October 2003.

[2] Intergovernmental Panel on Climate Change (IPCC) Climate change 2007: impact, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC Cambridge Univ. Press, Cambridge (2007), p. 976

[3] " Climate change knowledge portal for development PR actioners and policy markers " [Online].Available:http://sdwebx.worldbank.org/climateportal/index.cfm?page=downscaled_data_download& menu=historical [Accessed 11 February 2018].