For office use only	Team Control Number	For office use only
T1 _____	**76958**	F1 _____
T2 _____		F2 _____
T3 _____	Problem Chosen	F3 _____
T4 _____	**E**	F4 _____

2018
MCM/ICM
Summary Sheet

Summary

In order to quantify the States Fragility Index, we develop a comprehensive three-level indicator evaluation system based on the concept, which also can measure the impact of climate change.

First, we develop a compsite index, called States Fragility Index(SFI), which consists of social, economic, political and climate. Under the guidance of four selection criteria, 15 indicators are selected. The performance index is a linear composition of the indicators and principles. And their weight are determined by the Entropy method (EVM) and Factor Analysis method (FATT). Moreover, we quantify the influence of climate change, and divided the level of fragility.

Next, Sudan and Madagascar were chosen to study of the relationship between SFI and climate change. We find that they become more fragile when climate factors are considered. We predict the factors of climate, economic, social and political with ARIMA(2,2,2), and calculate the further SFI of Madagascar. We get the value of tipping point when Madagascar become more fragile.

Then, We regard the SFI of different years in a country as a time series, and add the intervention factor to constitute the Intervention Analysis Model(IA). Through analysis, we found that interventions such as reducing carbon emissions can have an impact on temperature indicators of climatic factors and improve SFI. And we develop a model to calculate the total cost of state intervention.

Finally, based on Dynamic Weighting method (DWM), we optimize the model to adapt to different geographic sizes, including continents and cities.

Keywords: States Fragility Index; Climate; Entropy Method; Intervention Analysis; Dynamic Weight

Contents

1 Introduction

1.1 Background

There exists no doublt in the significance of quantifying the country's fragility to formulate policies for government, espicially with the advent of big data era, which makes it easier for us to observer the dangers revealed by the Vulnerability index of our country and formulate corresponding countermeasures. At present the study of country's vulnerabilities has become a core issue for academics and policy makers in discussing the issues of global security, development and poverty.

As a result, many agencies began to experiment with preparation of devloping a model to quatify the National Vulnerability Index, such as Global Peace Pndex by Institute for Economic and Peace Research and the Political Instability Index by the Federation of Economists. One of the most famous is the Fragile States Index (FSI) , an annual report published by the Fund for Peace since 2005, which aims to assess state's vulnerability to conflict or collapse. And the Index's ranks are based on twelve indicators.[1]

However, none of the models above give any consideration to their accuracy or impact of climate change on the country's vulnerability.[2] In particular, the world climate is in a state of great instability. For example, some extreme weather frequently occur, which has changed human's way of lifr. Undoubtedly, this has had a tremendous impact on the fragility of a country or a government by changing some indicators directly or indirectly.

In view of those problems, We must first understand the definition of vulnerability. The term 'vulnerability' is used in many different ways by various scholarly communities. The resulting disagreement about the appropriate definition of vulnerability is a frequent cause for misunderstanding in interdisciplinary research on climate change and a challenge for attempts to develop formal models of vulnerability.[3]

Consequently, **we define the States Fragility as an objective indicator of the comprehensive reflection of economic, social, political and climatic conditions in this paper**.

1.2 Problem Statement

According to the Intergovernmental Panel on Climate Change (IPCC) assessment, global average surface temperatures have risen by 0.3 °C to 0.6 °C over the past century and global sea level has risen by 10-25 cm, which has led to many natural disasters directly or indirectly, such as droughts, floods, declining arable land and volatile weather so on. Many of these effects will change people's lifestyles and have the potential to undermine or disrupt social structures of government, which in turn will affect the country's vulnerability. There is also evidence of violent conflict when climate change is combined with weak governance and social divisions.

The ICM advocates that we help them to establish a model for measuring states vulnerability while measuring the impact of climate change. And we will examine the effects of climate change on specific states vulnerabilities. At the same time, we need to indicate what kind of interference is considered to mitigate the effects of climate change, and calculate the total cost of the intervention. Morevoer, we were asked to optimize our model to fit smaller cities or larger continents. The solution proposed in this paper will offer an insight to above problems.

1.3 Overview of Our Work

Our team is required to propose solutions for a series of processing tasks. Our work can be listed as follows:

- ✏ First, we re-described the definition of States Fragility based on the issue. Then, taking into account the basic idea of acquiring indicators and the four criteria (Society, Economy, Policy and Climate), we design a comprehensive indicator system to measure the States Fragility.Through Factor Analysis Method, we develop an objective model for calculating the States Fragility Index. Meanwhile, we give the relevant equations to determine the extent of climate change impact on vulnerability and identify the affected indicators.
- ✏ Second, we have chosen two countries as the research object, one is Sudan and the other is Madagascar. We calculate the Sudan's SFI and measured the impact of climate change on it. We find out that climate change had a negative effect on Sudan's SFI. As to Madagascar, we find that climate change has slightly increased its FSI. After investigation, we find the reason. Besides, We calculate the gray correlation of the indicators and identify how climate change impact on indicators. Last, With ARIMA (2,2,2), we obtain the predictive value of the indicator and find the turning point of the change of Madagascar's SFI.
- ✏ Then, we employ a model of intervention analysis. In conjunction with our model, we are trying to find out what kind of country-driven interventions which can mitigate the risk of climate change. At the same time, we set up a national intervention cost prediction model based on the concepts
- ✏ At last, we apply the method of dynamic weight to optimize our model, aiming to fit different area, such as continents and cities, which helps us to promote our model.

The flow chart of the whole model is presented below Fig.1:

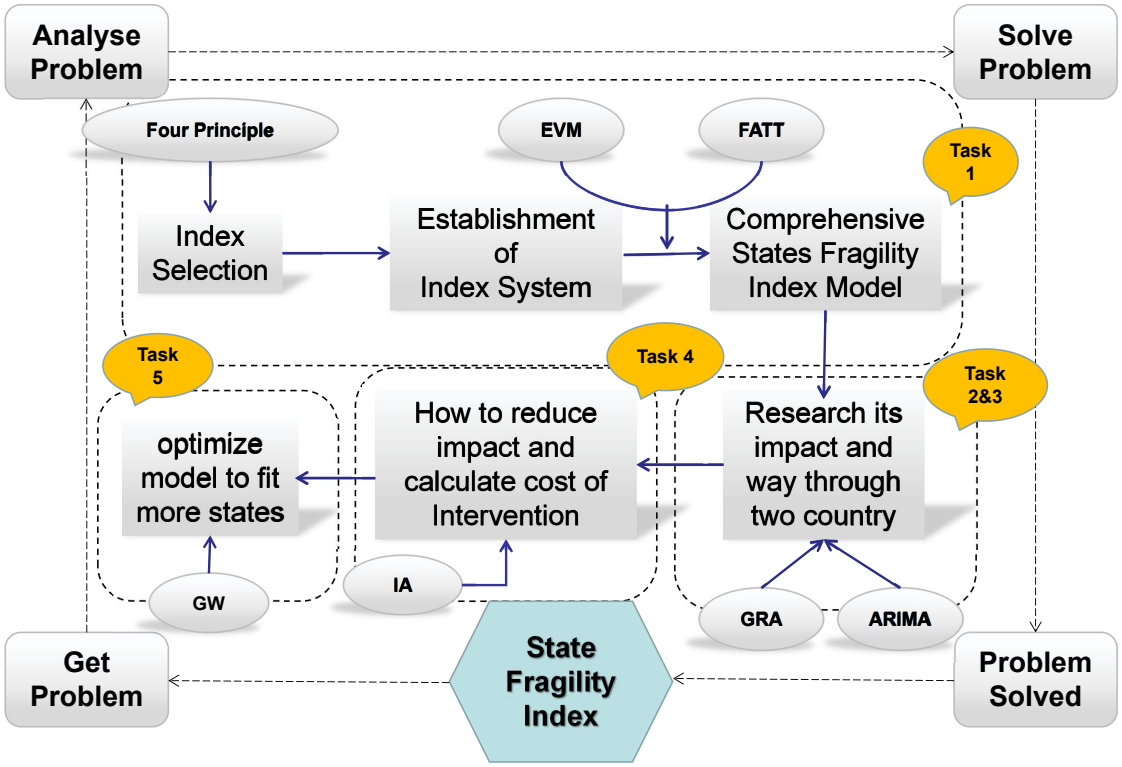

Figure 1: The Flow Chart of Our Work

1.4 The Advantage of Our Model

Our model has many advantages in statistics and evaluation:

- The evaluation model is based entirely on data without subjective or arbitrary decision rules.
- Our model succeeds in identifying the mechanisms by which climate change has a potential impact on states vulnerabilities rather than focusing on a superficial evaluation of a country.
- Our model takes full advantage of time-series data to produce reasonable results that can help us fully understand the real world.

2 Assumptions and Variable

2.1 General Assumptions

we construct the following assumptions to simplify complex issues because the issues discussed in this paper are large, generic, and abstract.

- We assume that the definition of states vulnerability in this paper is accurate although each institution has a set of standards of defining vulnerability of the states. We define the States Fragility as an objective indicator of the comprehensive reflection of economic, social, political and climatic conditions.

- We assume that the data provided by any agency or website is reliable and has not been externally influenced, which is the result of objective statistics.
- We assume that the states vulnerability index is a linear composition of all the selected indicators.
- We assume that climate change can be demonstrated by selected indicators, although climate change is a very complex issue.
- We assume that technology will not change much in the short term, thus neglecting the impact of technology on climate change.
- We assume that the common factors are not related, and the specific factors are not related. The common factors and the special factors are also not related to each other in Factor Analysis Method (TTFA).

2.2 Variable Description

Variables	Descriptions
x_i	the time series matrix of the i^{th} performance indicator
p_{ij}	proporth of the i^{th} sample under the j^{th} performance indicator of Index
e_j	the entropy of the j^{th} indicator
d_j	information entropy redundancy (difference)
w_j	the weight of indicators
$SFI(i)$	the i^{th} yaer of States Fragility Index
$influence$	the impact of climate change on States Fragliity Index

3 Data Processing

3.1 Data Collection

Collecting adequate data is the fundation for establishing a complete indicator system.

First, we searched for most of the literature on states fragility indicators, and reference to the selection of indicators for existing models to screen out the indicators we need.

Then, we searched the world database and found 15 relevant indicators for most countries. For example, we obtain the dataset of total population of the country from the World Bank, and GDP from the Knoema website.

3.2 Data Imputation and Normalization

Data missing is extreme common in statistics when some obstacles prevented us from observing the value of the variable successfully, but the availability of data is a significant issue. And we can't provide an accurate assessment if the data is unreliable.

Consequently, we should take some measure to ensure the authenticity and continuity of data.

- The value of indicator is missing more than 60%: we look for orther sufficient and equivalent indicator to replace it, or discard it.
- The value of indicator is missing more than 30%: we look for other countries with same changing characteristics to fill it.
- The value of indicator is missing lower than 30%: we use the method of regression prediction or simulation to fill it.

After Adressing the missing the data, we normalize the data, which turns a dimensionless expression into a dimensionless expression and map data to the range of 0 to 1. This papper use the following formula for normalization:

$$x_{ij} = \frac{max(x_j) - x_{ij}}{max(x_j) - min(x_i)} \tag{1}$$

where x is the value of indicator, μ is the average value, and σ is the standard deviation.

4 Comprehensive States Fragility Index Model

In this section, we will introduce how we select indicators of states fragility index and the use of factor analysis to construct a baseline model of the quantitatively calculated states fragility index. Then, we develop a model to measure the impact of climate change on states vulnerability, which helps us to recognize the change of climate change clearly. Finally, we analyze how the climate change affects performance indicators.

4.1 Indicator Selection

There is no doubt that how to quantify a country's vulnerability index system is very complex and difficult, which contains a very large number of indicators.

Based on the general idea of availability, comparability and operability, we selected four criteria layers of society, politicy, economy and climate. In practice, many institutions also focus on these core guidelines when they evaluate it. Logically, we choose the performance indicators that are relevant to these core guidelines. And we try to focus on the typicality and the representativeness of the indicators when we choose the indicators as the following Fig.2.

Therefore, we construct a evaluation index system based on the above principle before we develop our model, which contains 15 indicators related to the objectives and topics. And we analyse their advantages and limitations.

Properly, in a bid to simplify the calculation, we normalized all the indicators to ensure they are in the same range (from 0 to 1) .

The indicators what we select and its explnations will be shown in the below table 1.

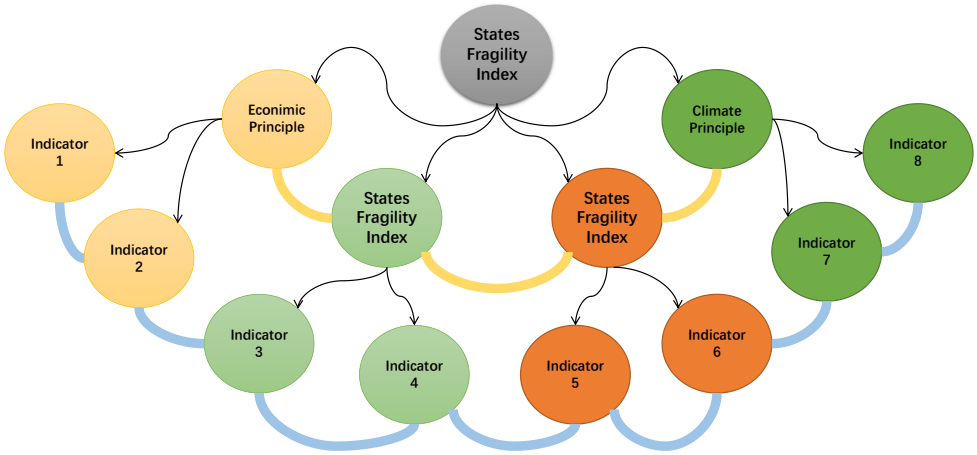

Figure 2: How to Select Indicator by Principle

Table 1: Indicators Selected

	Indicator_Name
Economic Principle	GDP
	GDP growth rate year on year
	GDP per capita
Social Principle	Population density
	Population growth rate
	Unemployment rate
	Per capita energy resources values
	People's Satisfaction with Democracy
Political Principle	National Corruption Perceptions Index
	The perfection of the law
	Public service expenditures (% of gdp)
	The number of criminal cases in every ten thousand people
	Military expenditures (% of gdp)
Climate Principle	Average temperature
	Average rainfall distance

4.2 The States Fragility Index Baseline Model

Based on the above analysis of potential indicators, we develop a model named The States Fragility Index Baseline Model (SFIBM) to quantify country fragility.

All we have to do is determine the weights of those variables because we assume the states fragility index is a linear composition of all performance indicators. Here, we apply the Entropy Weight method(EWM) to determine the weight of every indicator.

EWM is an objective method of weighting because it depends only on the discrete nature of the data itself. In information theory, entropy is a measure of uncertainty. That means that the entropy get smaller with large amount of information and smaller uncertainly. On the contrary, the entropy get greater with small amount of information and greater uncertainly. According to the characteristics of entropy, the entropy value can be used

to judge the randomness and disorder degree of an event. The entropy value can also be used to judge the degree of dispersion of an indicator. The greater the degree of discretization of the indicator, the impact of the indicator on the comprehensive evaluation (Weight) get greater.

Suppose we have the m performance indicators of a country with n years of data. And we denote the $x_i = (x_{i1}, x_{i2}, x_{i3}, \cdots, x_{in})^T$ as the time series matrix of the i^{th} performance indicator. Thus we construct data matrix of performance indicators:

$$X = (x_1, x_2, \cdots, x_m)$$

Then we can calculate proporth of the i^{th} sample under the j^{th} performance indicator in the Index of our model by using below equation:

$$p_{ij} = x_{ij} / \sum_{i=1}^{n} x_{ij} \tag{2}$$

888Next,calculating the entropy of the j^{th} indicator:

$$e_j = -k \sum_{i=1}^{n} p_{ij} ln(p_{ij}) \tag{3}$$

where $k = 1/ln(n) > 0$.

And we can get the weight of our indicators:

$$w_j = d_j / \sum_{j=1}^{m} d_j, j = 1, 2, \ldots, m \tag{4}$$

where $d_j = 1 - e_j$ as the information entropy redundancy (difference).

At last, we apply Factor Analysis Method to determind the contribution of c (principle), we get the States Fragility Index:

$$SFI = \sum c_i w_{ij} x_{ij} \tag{5}$$

All indicators in calculation are positive indicators, the lower composite score in the model, the more vulnerable the country is. The level of State Fragility is defined in this paper as the following table 2.

Table 2: The Level of Fragile

Definition	**Score**
Fragile	0-3
Vulnerable	3-7
Stable	7-10

4.3 Soulution to Measuring Climate Change Impact

To solve the problem how to measure the impact of climate change, we give a simple calculation based on the concept of derivatives.

- First, calculate SFI (States Fragility Index) S_1 and S_2 with/without taking consideration into climate change via our model.
- Then, let the two index subtract, that is $\Delta S = S_1 - S_2$
- Last, we can get the influence of climate change:

$$influence = \frac{\Delta S}{S_2} \tag{6}$$

4.4 Identify How Climate Change Impacts Indicators

In this paper, it is difficult to get satisfactory results by using the traditional correlation analysis directly. We have tried typical correlations and other methods, and the effect is not significant. After comparison, we apply Gray Relational Analysis to measure the correlation between climate change and the factor of economic, social and political.

The gray system theory proposes the concept of gray relational analysis, and attempts to seek the numerical relationship between subsystems (or factors). Therefore, the gray relational analysis method is based on the similarity or dissimilarity of the development trend between factors, that is, the "gray relational degree" as a measure of the correlation between factors.

It is simple to calculate the Gray Correlation Relevance, which can be listed as follows: (Here we only give the formula)

✷ **Seek the reference series and compare series of gray correlation coefficient** ξ:

$$\xi_{0i} = \frac{\Delta(min) + \rho\Delta(max)}{\Delta_{0i}(k) + \rho\Delta(max)} \tag{7}$$

✷ **Seeking relevance** r_i:

$$r_i = \frac{1}{N}\sum_{k=1}^{N}\xi_i(k) \tag{8}$$

5 Research in Two Countries

5.1 Sudan (Top10)

We chose Sudan that is One of the ten most vulnerable countries determined by FSI (Fragile State Index) as our research object because it is representative.

Applying our Comprehensive States Fragility Index Model and the data (2003-2016), we easily plot the change of Sudan's Index with/without taking consideration into climate change.

From the figure above, we can intuitively see the negative impact of climate change on States Fragility Index, which is in line with our common sense. In particular, climate change exert tremendous effect on Index in some years, and we conclude that Sudan was hit by a drought at that time according to its geographical location.

It's easy to draw a conclusion that countries may become less vulnerable without the effects of climate change.

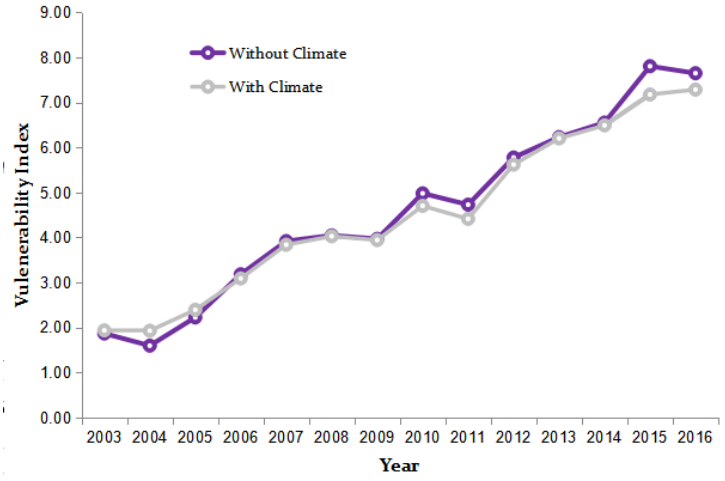

Figure 3: The Change of Sudan's Index

5.2 Madagascar (Not Top10)

5.2.1 Indentify how Climate Change Affect

In order to more directly observe the changes in the national vulnerability index in Madagascar, a time chart of the States Fragility Index with/without taking consideration into climate change is given below.

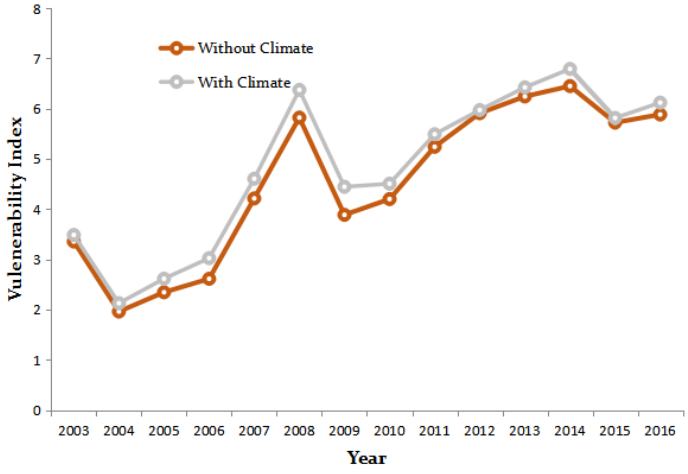

Figure 4: The Change of Madagascar's Index

As a result, the climate factor did not make Madagascar more vulnerable. After searching the information found that Madagascar is a famous tourist city, the geographical location and the natural environment is good, and the government actively involved in environmental management. It is not hard to explain, therefore, that Madagascar has become less vulnerable. This also corroborates the impact of climate factors on the country's vulnerability.

Then, we use the above gray correlation analysis model to calculate the correlation between factors. Relevance measures the size of the correlation between factors in the two systems over time. The greater the degree of correlation, the higher the correlation between the two is.

By using the gray relational analysis to analyze the correlation between climate and economy, society and politics, we get the below Gray correlation radar chart according to the correlation coefficient.

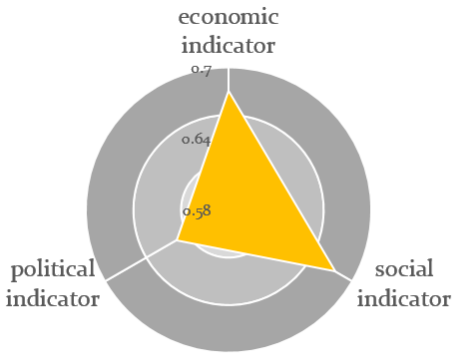

Figure 5: Gray Correlation Radar Chart

The results show that the gray correlation of climate and economic, social and political factors are all above 0.6, which means a strong correlation. It also shows that climate affects the vulnerability of our country by influencing economic, social and political factors.

In fact, the climate has a great impact on agricultural production, thus affecting the country's economy. Poor weather, such as high temperatures and heavy rainfall, easily lead to natural disasters, which threaten the lives and property of the people and even displace the people and increase the number of refugees. As a result, people complained and affected the rule of those authorities and national turmoil.

5.2.2 Time Series Prediction Model of Climatic Factors

We performed white noise and pure randomness tests on the sequences. The result is shown in below table 3.

Table 3: The Result of White Noise and Pure Randomness Tests

Hysteresis	γ^2	p-value
6	11.62	0.0710

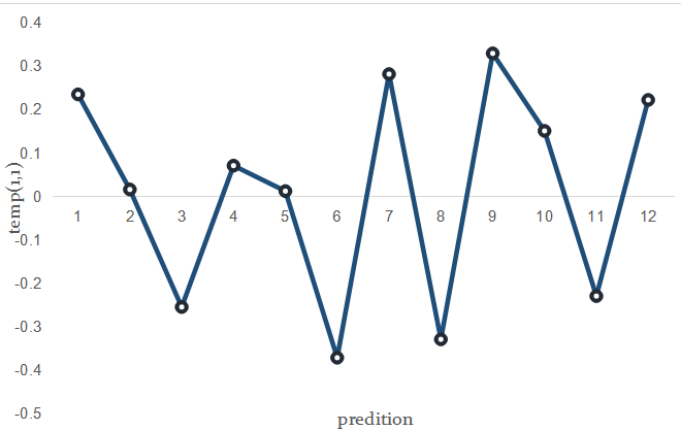

Figure 6: Temperature Sequence after the Second-order Differential Sequence

The p-value is less than 0.1 and the second-order difference time series(Fig.6) is approximately smooth, so the sequence has modeling significance.

According to the minimum information criterion of BIC, we obtain the time series model ARIMA (2,2,2). The model predicts the annual average temperature of Madagascar over the next five years with the following table 4.

Table 4: Madagascar average temperature forecast for the next five years

Year	Pre-Temp
2018	24.2212
2019	24.7964
2020	25.3467
2021	25.8738
2022	26.3784

From the results, Madagascar's annual average temperature increases year by year, consistent with the global climate warming environment. Guess the growth of temperature is most likely to increase Madagascar's vulnerability.

We use the same method to predict precipitation over the next five years. As can be seen from the results, the change in precipitation is not significant, so the main consideration is the temperature factor when discussing the impact of future climate on the SFI.

At last, according to disscussion above, we define the meaning of 'Turning-Point' as the SFI decrease to below 3, that is the country changed from ulnerable to fragile, as temperature reaching a high point.

6 Intervention Analysis Model

6.1 Climate Intervention Analysis Model

Since we already know that climate has an impact on states fragility, countries can decrease their vulnerability by taking some measures that have an impact on climatic factors. If the state does not intervene, climate change will have an impact on the economy and other factors. In consequence, it will affect the country's vulnerability index. For example, high temperatures can cause drought, affecting agricultural production and even

life and property losses. By taking methods like artificial rainfall and reducing greenhouse gas emissions, temperatures can be reduced and the impact of extreme weather can be alleviated.

Consider a country's vulnerability index as a time series and state policy interventions as an "emergency". Using Box and Tiao's intervention analysis model in 1975 can solve the impact of "emergencies" on time series. Intervention analysis model combines the intervention events and the time series model to study, which better deals with the policy changes or the impact of emergencies and the degree of their influences. This article uses an intervention analysis model to explore changes in states fragility when governments engage in climate change mitigation interventions.

Consider a country's vulnerability index as a time series and state policy interventions as an "emergency". Using Box and Tiao's intervention analysis model in 1975 can solve the impact of "emergencies" on time series. Intervention analysis model combines the intervention events and the time series model to study, which better deals with the policy changes or the impact of emergencies and the degree of their influences. This article uses an intervention analysis model to explore changes in states fragility when governments engage in climate change mitigation interventions.

$$P_t^T = \begin{cases} 1, t = T \\ 0, t \neq T \end{cases}$$

According to the theory of intervention analysis model, there are four types of interventions: the effects of intervention events suddenly start and continue, the effects of intervention events gradually increase and continue, the effects of intervention events suddenly start and the impact of intervention events gradually increases After the big decline. The impact of intervention on climate is not immediate. It is gradually and continuously affected, and will gradually disappear when it reaches a peak. This model can be expressed as follows.

$$X_t = \frac{\omega B}{\phi(B)} P_t^T, 0 < \delta < 1$$

The purpose of the intervention model is to measure the effects of the intervention. Time series without the influence of intervention can be fitted by ordinary time series analysis methods. Assuming that the original sequence model is an ARIMA model, the intervention model is constructed.

he stationary climate time series model can be expressed as $Y = \frac{\phi(B)}{\theta(B)}\alpha_t$. Suppose the influence of intervention variables as $Z = \frac{\omega B}{\theta B} I_t$, Where x is the intervention variable. So, the climate intervention model is

$$Y = \mu + \frac{\omega B}{\theta B} I_t + \frac{\phi(B)}{\theta(B)}\alpha_t$$

According to the principle of least amount of information in AIC, the ARIMA model is ranked and the parameters $\omega, \delta, \phi(B), \theta(B)$ are estimated. By evaluating the p-value of the model test for the impact of interventions, the impact of national intervention on climate can be obtained. The smaller the p value, the more significant the impact.

6.2 Intervention Cost Analysis Model

National policies or measures all require economic costs. If government does not take measures to intervene in the part that does not meet, it will bring loss. The costs of national intervention include the cost of construction (C), the cost of operation (O) and

the cost of maintenance (M). So we can define the cost of state intervention as the cost of the intervention minus the loss of property without intervention.

The costs of intervention on the climate management vary in different countries. The higher the level of ecological damage in the country, the greater the difficulty of restoration and the greater the cost of climate management. However, in developed countries, the overall economic losses caused by extreme weather disasters. Here GDP is used as a measure of the degree of national development.

Define the the level of ecological damage as E. So we can define the the cost of state intervention as follews.

$$W = C + O + M + k_1 E - \frac{k_2}{GDP}$$

7 Extended Model: Dynamic Weight to Fit Different Area

Let us consider the question of whether our model is adaptable to smaller cities or larger continents. Obviously, we can not apply directly. For the continents, the indicators we choose can not accurately show their vulnerability's feature because larger area will dilute the value and meaning of indicators. And meanwhile, larger area requires the introduction of more indicators to describe its overall characteristics, otherwise we will get a wrong answer. For cities, Small area will make our model appear overly calm, because the changes in indicators can not keep up with changes in the city. Thus, we employ the method of Dynamic Weighting to solve the problems we analyse.

According to the actual background of the issue and the general principles of comprehensive evaluation, the process of solving problem can be listed in three steps.

- **Standardize the indicators of evaluation system.** we can use below equation for calculating in this paper.

  $$x_i^{''} = \frac{x_i^{'} - m_i^{'}}{M_i^{'} - m_i^{'}}$$

  where $x_i^{'} = \frac{1}{x_i}$ and $M_i = max(x_i)$

- **Setting Dynamic weight fuction:** Taking into account the "qualitative difference" and "quantity difference" of the evaluation indicator, in determining the comprehensive evaluation index, it is necessary to reflect the differences between different types of indicators as well as the quantitative differences of the same type of indicators. In this paper, We recommend using:

  $$w_i(x) = \begin{cases} 0, x \leq \alpha_i \\ 1 - e^{-\frac{x-\alpha_i}{\alpha_i}^2}, x \geq \alpha_i \end{cases}$$

  where we let the $\alpha_i = \mu(x_i)$.

- **Construting Comprehensive Evaluation Model:** According to the value of indicators after standardization, we can get our model with Dynamic Weight Method:

  $$SFI = \sum c_i w_{ij} w(x_{ij}) x_{ij}$$

The method of dynamic weighted comprehensive evaluation makes the evaluation results scientific and reasonable. The main advantage of dynamic weighting is that it fully takes into account all the different influences and effects of each attribute of each factor. In the meantime, it also fully reflects the "universality" and "democratization" of

each attribute in the comprehensive evaluation. It truly reflects the meaning of the "comprehensive" three-character of the comprehensive evaluation. This method increases the objectivity of the comprehensive evaluation and greatly destroys the influence of the appraiser's subjective factors on the evaluation results .

8 Conclusions and Discussion

8.1 Conclusions

This paper manages to develop three chlimate change model to discribe how the climate change influences the fragility of a country. In addition, our model exhibits a great potential in drawing the conclusions below:

- We identify three main contributing indicators to discribe the fragility of a country. Based on these indicators, we further identify 14 second indicators to measure the first indicators which reveals how climate change increases fragility, according to the dimensions sphere and knowledge domain.
- We formulate the Comprehensive States Fragility Index Model(CSFI) based on the Entropy Weight Method in order to develop an appropriate concept for States Fragility Index (SFI) measures countries' level of fragile.
- We regard economy, society and politics as main indicators of our model. Then focused on the issues that the supervisor need us to deal with, we apply the Gray Relational Analysis to examine the correlation between main indicators and the climate. Based on our simulation results, we obtain our predictions for these issues and analyze effects, and we conclude that climate change will indeed influence the fragility.
- Through White Noise and Pure Randomness Tests, we find that country-driven interventions can mitigate the risk of climate change, such as building bams or realigning the river to prevent the landflood, improvng the agro-ecological environment in arid area like planting drought-enduring crop, and so on.
- At last, we find that insufficient or oversize area will disturb the authenticity of area, so we revise our model's initial parameters and algorithms with dynamic weight method, and fit different area successfully.

8.2 Limitationand Extensions

Though our model successfully revealed the influence of climate change to the fragility of countries, it has several ways to be improved:

- Limited by lack of data or data missing, some values of the indicators can be only estimated, which can be inaccurate. We are focused to forecast some data in order to fill tables or matrices. Inaccurate data may cause by errors.
- Before we calculated the States Fragility Index, we just identified 2 second indicators to measure the climate indicator. Similarly, some significant indicators were missing or abandoned at the first time we build the model. so that we'd better conduct more sufficient analysis about quantifying the fragility better and keeping the model's adaptive abilities. This requires us to collect more research data on a wider range.

- According to the dynamic weight method, the simulation results depend on largely the initial values. Therefore, countries will become fragile under many types of climate changes, and our model measures them into index on many assumptions that may neglects their reality and diversity. In order to model a real world scenario, these assumptions would need to be removed.

References

[1] https://en.wikipedia.org/wiki/Fragile_States_Index

[2] Vijayan, S..The Fallacy of Failed States:A Critique of The Annual Failed (Fragile) States Index by Fund For Peace.

[3] Hans-Martin Fussel, 2006. Vulnerability: A Generally Applicable Conceptual Framework for Climate Change Research. Global Environmental Change, 155-167.