Problem Chosen	2022	Team Control Number
D	ShuWei Cup	2022111313961
	Summary Sheet	

Study on the La Nina Phenomenon

Summary

La Niña refers to the phenomenon that the sea surface temperature in the eastern and central equatorial Pacific continues to be abnormally cold (contrary to the El Ni ñ o phenomenon), which also becomes an anti El Ni ñ o phenomenon and is the product of the joint action of tropical oceans and the atmosphere.The harm caused by La Niña is obvious, so it is particularly important to predict the possibility of its occurrence and take corresponding countermeasures.

For problem 1:First of all, we conducted statistical analysis on the major countries and regions affected by La Niña in the world. Through collecting data, we found that there are four major monitoring regions for La Niña, and based on this, we counted the major countries and drew the corresponding **disaster distribution map**;For the second question, through searching for data, this paper finally takes sea surface temperature as the main factor of La Niña phenomenon, and forecasts the sea surface temperature change in the next three years in four major regions with the data from 1950 to now through the **seasonal ARIMA prediction model**, The predicted sea surface temperature is used to calculate the probability of La Niña in the four major regions through the **binomial logistic regression model**, and **the specific year of occurrence in most regions is from August to February to March of the next year.** Finally, the probability of the future triple La Niña events is between 60% and 70%.

For problem 2:In this paper, **India** is selected as the drought disaster country. Through collecting the corresponding data over the years of this country, the corresponding **evaluation index system** suitable for this country is established, and the case data of future disasters are predicted through the model of Question 1,The **maximum deviation** and **interval fuzzy entropy weight methods** are used to determine the weights respectively, and the two weights are combined through the **principle of minimum information identification**,Finally, the grade score calculated by **interval fuzzy evaluation method** is (0.5101, 0.5703), which is between the range of moderate disasters. Finally, it is determined that the country may suffer from **moderate drought** in the future;From the perspective of index weight, it can be seen that the country's **capacity of drought prevention and disaster reduction** has the greatest impact on the drought.Secondly, the background conditions of the disaster;Therefore, this paper focuses on putting forward some corresponding prevention strategies to reduce the losses that may be caused by drought in the future.

For problem 3:This paper selects **Brazil** as the research object of flood disaster,We also collected the loss data of the country affected by this disaster over the years, and took the proportion of direct economic loss, the proportion of affected population, the proportion of affected area and the proportion of comprehensive relative disaster as **loss indicators**,then, the corresponding **disaster index grade** is calculated based on the **Grey correlation degree**, and the future **flood disaster** caused by La Niña in the country is determined to **be medium**,at the same time, the correlation between the comprehensive index of heavy precipitation and the four indicators was analyzed, **Pearson correlation** analysis was conducted and the significance test was passed,therefore, **the flood disaster vulnerability curve of RPI** and the above four indicators is established, and the relationship between them is a **power function**,It shows that the loss will decrease with the increase of RPI. Therefore, this paper puts forward some corresponding flood disaster prevention strategies for these indicators, so as to reduce losses.

For problem 4:Based on the conclusions of the first three questions,this paper has written a 2000 word prevention report on the possible harm caused by the future La Ni ñ a incident to the corresponding relevant departments

key word: prediction model Principle of minimum information identification Interval fuzzy evaluation method Vulnerability curve of flood disaster

Content

1.Problem restatement and analysis

1.1 Background

From July to August 2022, many cities in southern China began to experience high-temperature weather, which lasted for many days, while some areas in the north also experienced large-scale heavy rainfall.

In addition, many European countries have also experienced drought disasters rarely seen in history. Whether it is high temperature in the south, heavy rainfall in the north, or dry weather in Europe, it is unprecedented in decades. The data of the highest temperature, heavy rainfall and drought disasters have also broken through the historical height, surpassing the data since the beginning of detection by the meteorological bureau. The severe high temperature weather has caused economic losses and casualties in many cities in the south and European countries. The same situation has also occurred in the north, where heavy rainfall has greatly reduced agricultural production in some areas, even without harvest. The meteorological department attributed the high temperature and heavy rainfall events to the " La Niña " event.

1.2 work

In recent years, La Niña incidents have become more frequent, even the Triple La Niña incident in the 21st century. The La Niña incident will cause multiple rare disasters. In order to better predict and prevent the La Niña incident and post disaster reconstruction.

Based on the above background information, we need to establish a mathematical model to solve the following problems:

1. It is necessary to conduct statistical analysis on various indicators of countries and regions where La Niña events are raging, and predict the possibility of La Niña events in the future, so as to better prevent and reduce the losses caused by La Niña events to countries and regions
2. The Triple La Niña Event has caused high temperature and drought disasters in many places. It is necessary to assess and analyze the losses of various heat and drought disasters caused by La Niña event, so as to better carry out pre disaster prevention and post disaster reconstruction, reduce losses and propose targeted coping strategies based on the analysis results.
3. The Triple La Niña Event also caused flood disasters, and the assessment and analysis of flood disaster losses also put forward targeted measures.
4. Write a report based on the conclusions of (1), (2) and (3) to submit to the relevant management

1.3 Ideas for the problem to be solved

Solution to problem one : For the first question, this paper first collects the countries that have been affected by La Nina events in the world over the years, draws the distribution map, and counts the countries and regions that are mainly affected. For the second question, because the root of La Nina phenomenon is caused by the continuous abnormal cold sea surface temperature in the eastern and central equatorial Pacific, the sea surface temperature of the four monitoring areas of La Nina phenomenon is selected as the basis for studying the occurrence of La Nina phenomenon.In this paper, we will predict the next three years through the data of the four monitoring areas of the La Nina phenomenon from 1950 to the present through the seasonal ARIMA model, and then predict the probability of the four regions in the next three years and the specific years and months through the Logistic regression model according to whether the four regions have experienced the influence of the La Nina event over the years. Finally, according to the four regions, the probability range of global La Nina time occurrence is obtained.

Solutions to problem two : For the second question, this paper selects India as the research object of this topic. By collecting all aspects of the losses caused by the La Nina phenomenon over the years, the evaluation index system is established, and the drought losses that may be suffered in the future are predicted according to the loss data over the years. Here we call it the prediction example data.Then, according to the established evaluation index system, the weight is determined by the idea of maximizing deviation and the weight is determined by the interval fuzzy entropy weight method, and then the minimum information identification principle is used to combine the weights to obtain better weights, so as to determine the degree of disaster by the interval fuzzy evaluation method.Finally, according to the size of the weight can determine the impact of its impact indicators on the country ' drought can be determined, so as to propose targeted prevention strategies for the relevant departments.

Solutions to problem three : In view of this problem, we take Brazil as an example to study its flood disaster. It is also necessary to collect all aspects of the losses caused by the flood disaster caused by the La Nina phenomenon in previous years, and finally establish four main loss indicators, the proportion of direct economic losses, the proportion of affected population, the proportion of affected area and the proportion of comprehensive relative disaster, and then calculate the corresponding disaster index respectively, so as to determine the severity of the disaster according to the classification of the disaster index.Then, according to the Pearson correlation test between Brazil 's heavy rainfall composite index (RPI) and the above four indicators, the flood disaster vulnerability curve of RPI and these four indicators is drawn, and then the direction of prevention is analyzed, and favorable measures are proposed to the relevant departments to reduce the impact of disasters.

Solutions to problem four : This paper intends to synthesize the conclusions of the first three questions, from environmental protection, international cooperation in research, the establishment of early warning mechanisms, people 's awareness of disaster prevention and other aspects of the relevant world meteorological organization, the united nations and other organizations to write a report on the effective control of damage.

2.Problem assumption

Hypothesis 1 : Losses resulting from other disasters not considered during this period.

Hypothesis 2 : Find the data obtained are true and valid.

3.Symbol description

sign	meaning
X_{t+h}	Predicted value for h period
Y	The 0-1 variable of La Nina event
W_A	Weight obtained by maximum deviation method
W_S	Weights obtained by interval entropy weight method
W_Z	Minimum information identification combination weighting
$Grade$	Interval fuzzy evaluation score
Z	Integrated index of relative disaster

4.Answer to question one

4.1 Establishment of model

4.1.1 Simple seasonal model

The occurrence of La Niña event is seasonal[1], and the simple seasonal model contains stable seasonal components without trends.The simple seasonal model is similar to SARIMA (0,1,1) x (0.1.1) s.SARIMA model first converts the non-stationary time series into stationary series by difference, then regresses the dependent variable only to its lag value and the present value and lag value of the random error term, describes it with a class of sparse coefficient ARIMA model, and then establishes the model.

The simple seasonal model formula is:

$$l_t = \alpha(x_t + s_{t-m}) + (1-\alpha)(l_{t-1} + b_{t-1}) \tag{1}$$

$$b_t = \beta(l_t - l_{t-1}) + (1-\beta)b_{t-1} \tag{2}$$

$$S_{\mathrm{t}} = \gamma(X_t - l_{t-1} - b_{t-1}) + (1-\gamma)S_{t-m} \tag{3}$$

$$X_{\mathrm{t}+h} = l_t l_t + hb_t + S_{t+h-m(k+1)}, k = \left[\frac{h-1}{m}\right] \tag{4}$$

Where, m is the cycle length (12 for monthly data and 4 for quarterly data), α is the horizontal smoothing parameter γ is the trend smoothing parameter, h is the expected number of lead times, and X_{t+h} is the forecast value of the h period.

4.1.2 Forecasting the possibility of La Niña event based on logistic regression model.

The basic equation sets the dependent variable Y as the sea surface temperature predicted by time series, and the event of La Niña event

$$Y = \begin{cases} 1 & \text{La Nina events occur} \\ 0 & \text{La Nina events did not occur} \end{cases} \tag{5}$$

The independent variables X_1, $X_2, \cdots, X_m$ are the factors that affect the process step.Under the action condition of m variables, the probability of Y event occurrence is recorded as[2]:

$$P = P(Y = 1 / X_1, X_2, \cdots, X_m)\text{，}\quad 0 \le P \le 1 \tag{6}$$

$$P = \frac{1}{1 + \exp[-(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_{\mathrm{m}} X_m)]} \tag{7}$$

$$\text{If: } Z = \exp[-(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta X_m)] \tag{8}$$

Then Formula (1) can be simplified into: $P = \dfrac{1}{1 + \mathrm{e}^{-\mathrm{z}}}$

Where β_0 is a constant term, where $\beta_1 \beta_2 \cdots \beta_{\mathrm{m}}$ is a regression coefficient, indicating that the independent variable X_{j} changes by a unit of $\mathrm{log}itP$ .The above formula can be converted into:

$$\ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_m X_m = \log itP \tag{9}$$

Range of values, probability P：0~1， $\mathrm{log}itP : -\infty \sim +\infty$.

4.2 Solution of model

La Niña refers to the phenomenon that the sea surface temperature in the eastern and central equatorial Pacific continues to be abnormally cold (the sea surface temperature is more than 0.5 ℃ lower than the average climate value, and lasts more than 6 months), which is the product of the joint action of tropical oceans and the atmosphere.El Nino usually disrupts the usual climate characteristics of a region, that is, the rainy season appears severe drought, while the cold season is unusually high temperature; While La Niña will not distort the climate characteristics of a certain region, it can strengthen the climate characteristics of the region.According to NASA and other platforms, the main areas where the La Niña incident occurred are mainly divided into four key detection areas,They are *Zone NINO1+2*($90^{\circ}W \sim 80^{\circ}W$, $10^{\circ}S \sim 0^{\circ}$)、*Zone NINO3*($150^{\circ}W \sim 90^{\circ}W, 5^{\circ}S \sim 5^{\circ}N$)、*Zone NINO4*($160^{\circ}E \sim 150^{\circ}W, 5^{\circ}S \sim 5^{\circ}N$)and *Zone NINO3.4*($170^{\circ}W \sim 120^{\circ}W, 5^{\circ}S \sim 5^{\circ}N$).

Therefore, this paper collected the major countries and regions in the world affected by La Nina events and plotted them as follows:

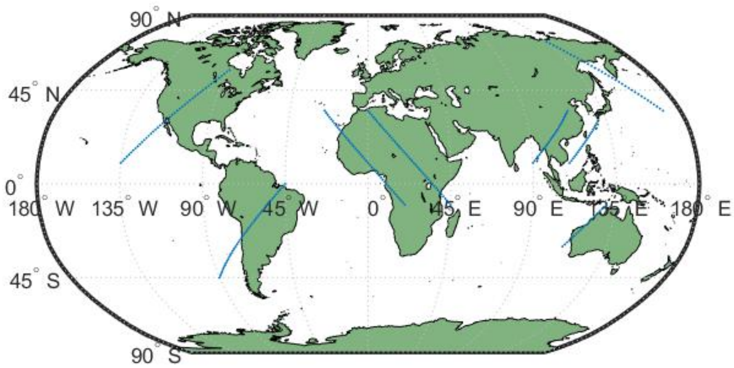


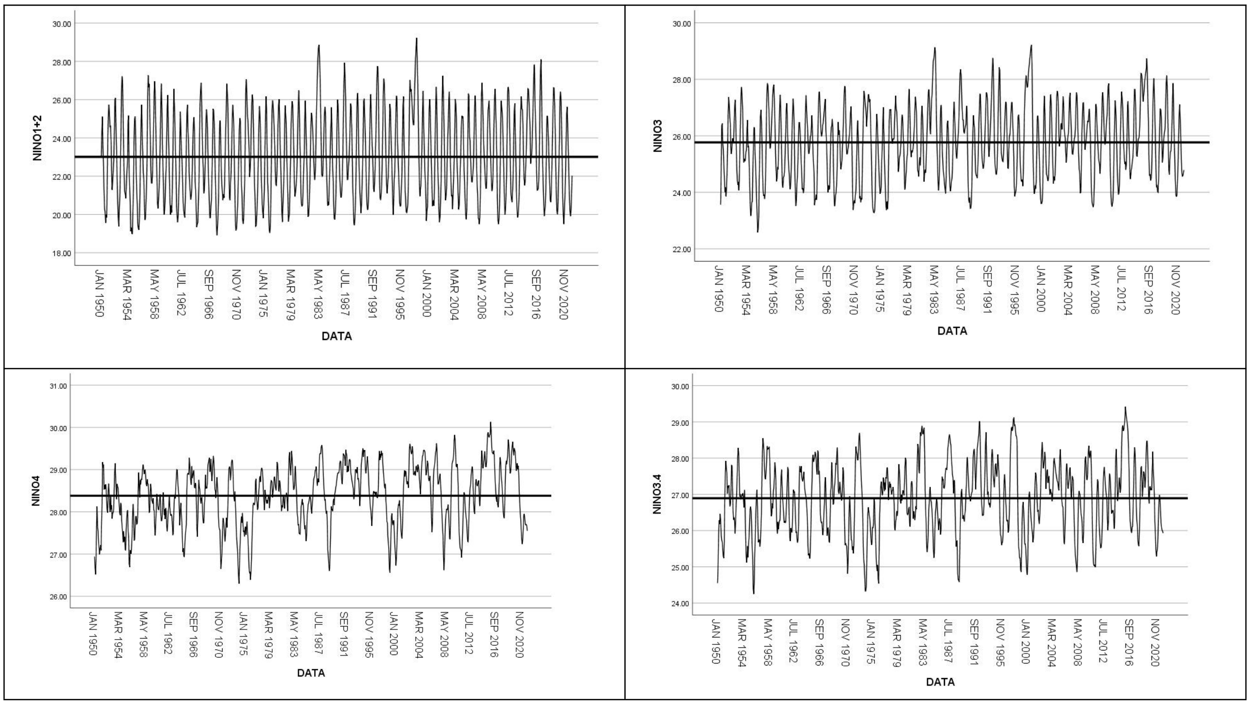
Figure 4.2.1 Map of major countries and regions affected by La Nina events

The image above shows the major regions and countries affected by La Nina across the globe. The direct line runs through the major affected areas, mainly in South America, parts of Australia, North China and Yunnan.

At the same time, the main factor of La Niña event is a series of reactions caused by the continuous anomaly of sea surface temperature, so this paper selects sea surface temperature as the main basis for predicting La Niña event.

The sea surface temperature data of four regions since 1950 and the corresponding indexes of each region are obtained by querying the data.Then, the stability of the time series of these four regions is observed by drawing a time sequence diagram as follows:

Table 4.2.1 Time Series Diagram of the Four Regions



It can be seen from the images that the time series of the four regions show a trend of uniform fluctuation, and have certain seasonal laws.The results of model building through SPSS software expert modeler are as follows:

Table 4.2.2 Model table

ID	Model	Model type
NINO1+2	model_one	Simple seasonality
NINO3	model_two	ARIMA(1,1,10)(0,1,1)
NINO4	model_three	Simple seasonality
NINO3.4	model_four	ARIMA(0,1,2)(1,0,1)

The models of NINO1+2 and NINO4 are selected as simple seasonal models,The seasonal ARIMA model is adopted for NINO3 and NINO3.4,this is the SARIMA model.Fitting statistics and test statistics of each model are shown in Table 4.2.2 below, and the residual error of the model since the correlation and partial correlation diagram as shown in Table 4.2.1

Table 4.2.3 Model Test Statistics

Model statistics						
	Number of forecast variables	Model fit statistics	Yang Box Q(18)			Number of outliers
Model		Stable R-square	Statistics	DF	Significance	
NINO1+2-Model_1	0	.527	54.154	16	.000	0
NINO3 -Model_2	0	.605	25.512	13	.020	0
NINO4 -Model_3	0	.540	157.309	16	.000	0
NINO3.4 -Model_4	0	.580	55.931	14	.000	0

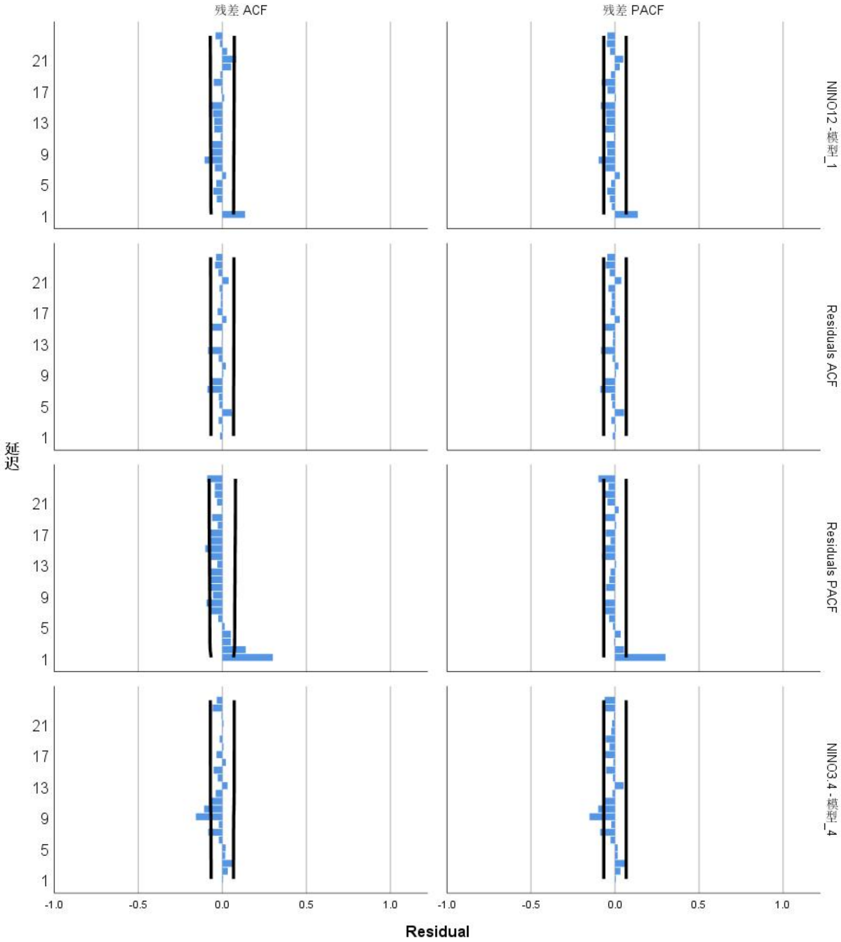


Figure 4.2.2 Residual Test Chart

It can be seen from the figure that the autocorrelation coefficients and partial autocorrelation coefficients of the residuals in the four regions are basically stable, basically within the confidence interval, and the four models have passed the significance test through the Yang Box test, so the residual sequence of the four models can be considered as a white noise sequence.At the same time, the fitting determination coefficients of the models are also greater than 0.5, and the goodness of fit of the models is good.In order to observe whether the triple La Niña event will occur in the future, it is necessary to forecast it to December 2024,Some of the predicted data are shown in Table 4.3.3 below.

Table 4.2.3 Partial forecast data table

Model		*October 2022*	*November 2022*	*December 2022*	*January 2023*	*February 2023*	*March 2023*	*April 2023*
NINO1+2-Model_1	*forecast*	20.19	20.88	22.03	23.73	25.24	25.62	24.71
	UCL	23.01	23.84	25.12	26.94	28.57	29.07	28.28
	LCL	17.37	17.92	18.94	20.51	21.9	22.17	21.1

								5
NINO3 -Model_2	*forecast*	24.51	24.62	24.76	25.16	25.91	26.72	27.1
	UCL	26.87	27.05	27.25	27.71	28.52	29.39	29.83
	LCL	22.15	22.19	22.27	22.61	23.3	24.05	24.38
NINO4 -Model_3	*forecast*	27.7	27.67	27.55	27.34	27.24	27.34	27.61
	UCL	28.88	28.91	28.84	28.68	28.63	28.78	29.1
	LCL	26.52	26.43	26.26	25.99	25.84	25.89	26.12
NINO3.4-Model_4	*forecast*	26.02	26	25.94	25.91	26.11	26.61	27.06
	UCL	28.28	28.38	28.43	28.51	28.82	29.42	29.98
	LCL	23.75	23.62	23.44	23.3	23.39	23.79	24.14

(Due to the limited length of the article, only part of the forecast data is displayed, and the detailed data can be seen in the supporting materials.)

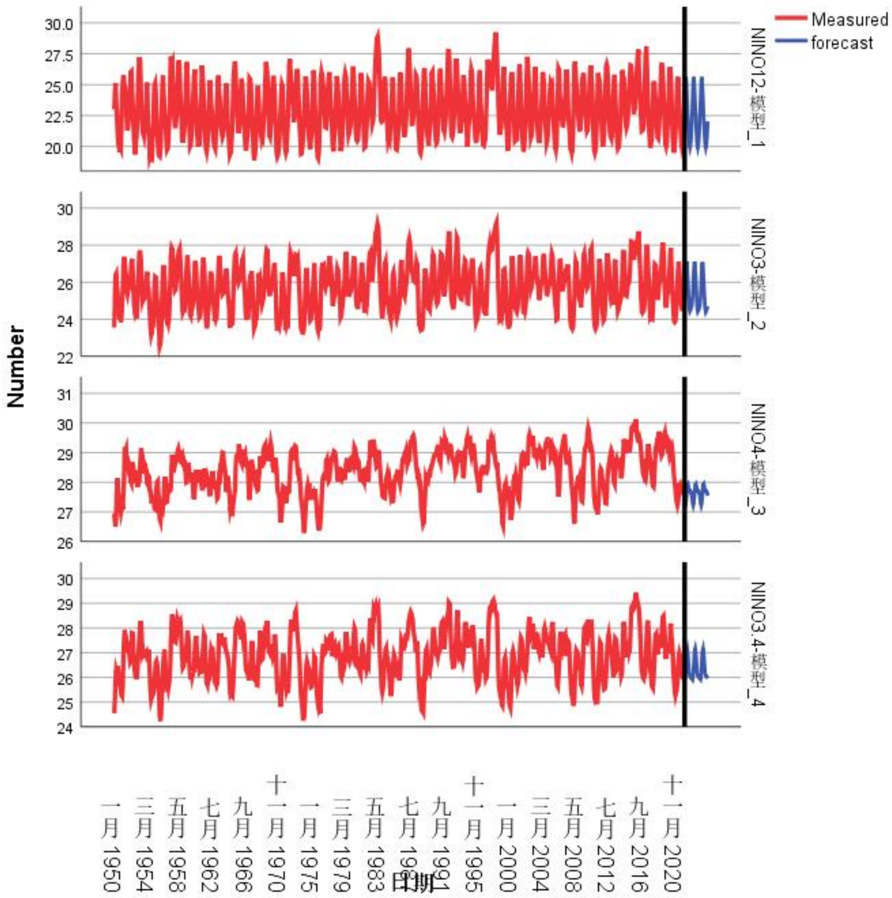


Figure.4.2.3 Prediction data visualization

Then we use the La Ni ñ a event under the temperature over the years and the sea surface temperature data predicted by time series to predict the possibility of La Ni ñ a event by binary logistic regression， 1 represents the occurrence of La Niña event, 0 represents the absence of La Niña event，The sea surface temperature data over the years from 1950 to 2020 are used for training, and the training prediction success rate is shown as follows:

Table 4.2.4 Prediction success rate table

Measured value		Forecast NINO1+2 Occurrence result		Correct percentage
		0	1	
NINO1+2 Occurrence result	0	297	162	64.7%
	1	146	247	62.8%
Overall percentage				63.8%

Measured value		Forecast NINO3.4 Forecast results		Correct percentage
		0	1	
NINO3.4 Forecast results	0	579	0	100%
	1	321	0	0
Overall percentage				64.3%

Measured value		Forecast NINO3 Occurrence result		Correct percentage
		0	1	
NINO3 Occurrence result	0	525	0	100%
	1	327	0	0
Overall percentage				61.6%

Measured value		Forecast NINO4 Occurrence result		Correct percentage
		0	1	
NINO4 Occurrence result	0	601	0	100%
	1	251	0	0
Overall percentage				70.5%

The coefficient table of the corresponding logical regression equation of the four regional logical regression models is as follows:

Table 4.2.5 Table of regression model coefficients

NINO4 Coefficient table of logical regression equation						
	B	Standard error	wald	free degree	Significance	Exp(B)
NINO4	-7.624	0.662	132.708	1	0	0
constant	213.51	18.563	132.297	1	0	5.323E+92
NINO3 Coefficient table of logical regression equation						

	B	Standard error	wald	free degree	Significance	Exp(B)
NINO3	-1.368	0.095	208.539	1	0	0.255
constant	34.492	2.41	204.792	1	0	9.5466E+14

NINO3.4 Coefficient table of logical regression equation

	B	Standard error	wald	free degree	Significance	Exp(B)
NINO3.4	-917.141	4431.212	0.043	1	0.836	0
constant	24295.268	117382.347	0.043	1	0.836	.

NINO1+2 Coefficient table of logical regression equation

	B	Standard error	wald	free degree	Significance	Exp(B)
NINO1+2	-0.402	0.037	119.567	1	0	0.669
constant	9.047	0.841	115.804	1	0	8489.325

The corresponding equation is as follows:

NINO1+2 Logical regression equation:

$$Y_i = \frac{e^{9.047-0.402NINO1+2}}{1+e^{9.047-0.402NINO1+2}} \tag{10}$$

NINO3.4 Logical regression equation:

$$Y_i = \frac{e^{24295.268-917.141NINO3.4}}{1+e^{24295.268-917.141NINO3.4}} \tag{11}$$

NINO3 Logical regression equation:

$$Y_i = \frac{e^{34.492-1.368NINO3}}{1+e^{34.492-1.368NINO3}} \tag{12}$$

NINO4Logical regression equation:

$$Y_i = \frac{e^{213.51-7.624NINO4}}{1+e^{213.51-7.624NINO4}} \tag{13}$$

If $Y_i \geq 0.5$，It is believed that the La Nina event will occur in this area, that is, 1, and the probability of occurrence is the corresponding probability of successful prediction. Therefore, the predicted La Niña events in the next three years are as follows:

Table 4.2.6 Predictive table of future La Nina events

DATA	NINO3.4	NINO4	NINO3	NINO1+2
2022.1	1	1	1	0
2022.2	1	1	0	0
2022.3	0	1	0	0
2022.4	0	1	0	0
2022.5	0	1	0	0
2022.6	0	1	0	1
2022.7	0	1	0	1

2022.8	1	1	1	1
2022.9	1	1	1	1
2022.10	1	1	1	1
2022.11	1	1	1	1
2022.12	1	1	1	1
2023.1	1	1	1	0
2023.2	1	1	0	0
2023.3	0	1	0	0
2023.4	0	1	0	0
2023.5	0	1	0	0
2023.6	0	1	0	1
2023.7	0	1	0	1
2023.8	1	1	1	1
2023.9	1	1	1	1
2023.10	1	1	1	1
2023.11	1	1	1	1
2023.12	1	1	1	1
2024.1	1	1	1	0
2024.2	1	1	0	0
2024.3	0	1	0	0
2024.4	0	1	0	0
2024.5	0	1	0	0
2024.6	0	1	0	1
2024.7	0	1	0	1
2024.8	1	1	1	1
2024.9	1	1	1	1
2024.10	1	1	1	1
2024.11	1	1	1	1
2024.12	1	1	1	1

From the table, we can see that in the NINO3.4 area, there is a 64.3% probability of La Niña events occurring in January to February 2022, from July to February 2023, from September 2023 to February 2024, and from August to December 2024. In the NINO4 area, 70.5% of La Niña events will continue to occur in the next three years. In the NINO3 area, there is a 61.6% probability of La Niña events occurring in August 2022 to January 2023, from August 2023 to January 2024, and from August to December 2024, In the NINO1 1+2 region, there will be 63.8% probability of La Niña event from June to December 2022, June to December 2023, and June to December 2024. Therefore, there is a 60%~70% probability that the triple La Niña event will occur in the future on a global scale.

5.Answer to question two

5.1 Establishment of model

5.1.1 Combined weighting model for disaster loss evaluation based on maximum deviation and entropy weight method

1.Positive and fuzzy indicators

In this paper, according to the evaluation criteria of different grades of drought risk evaluation indicators, see Table 1. The data in the table shall be dimensionless with the following formula.

（1）Benefit oriented:

$$\mu(x)=\begin{cases}1 & (x \ge x_{\max}) \\ \dfrac{x-x_{\min}}{x_{\max}-x_{\min}} & (x_{\min} \le x \le x_{\max}) \\ 0 & (x \le x_{\min})\end{cases} \tag{14}$$

（2）Cost type:

$$\mu(x)=\begin{cases}1 & (x \le x_{\min}) \\ \dfrac{x_{\max}-x}{x_{\max}-x_{\min}} & (x_{\min} \le x \le x_{\max}) \\ 0 & (x \ge x_{\max})\end{cases} \tag{15}$$

2.The maximum deviation determines the index weight

For a multi-attribute decision making problem, when the attribute weight information is unknown, the idea of deviation maximization can be used to determine the weight, that is, the greater the deviation value of an attribute for different schemes, the greater the weight of the attribute[3].

For attribute Q_{j}, the deviation of scheme P_{i} to all other schemes is：

$$D_{ij}=\sum_{k=1}^{m} d(E_{kj,}E_{ij})\omega_j \qquad (i=1,2,\cdots,m;\, j=1,2,\cdots,n) \tag{16}$$

Among them, $E_{ij}(i=1,2,\cdots,m;\, j=1,2,\cdots,n)$ Is the interval index value of attribute Q_{j} for scheme P_{i}, $d\left(E_{kj},E_{ij}\right)$ is the distance between E_{kj} and E_{ij} 。

The deviation values of all schemes against other schemes are respectively：

$$D_j(\omega_j)=\sum_{i=1}^{m}\sum_{k=1}^{m} d(E_{kj},E_{ij}) \tag{17}$$

The total deviation value of all attributes for all schemes is：

$$\max D(w_j)=\sum_{j=1}^{n}\sum_{i=1}^{m}\sum_{k=1}^{m} d(E_{kj},E_{ij})\omega_j \tag{18}$$

Construct the following nonlinear equation and Lagrange function to calculate the weight ω_j

$$\max D(w_j)=\sum_{j=1}^{n}\sum_{i=1}^{m}\sum_{k=1}^{m} d(E_{kj},E_{ij})\omega_j \tag{19}$$

$$L(\lambda,\omega_j)=\sum_{j=1}^{n}\sum_{i=1}^{m}\sum_{k=1}^{m}d(E_{kj},E_{ij})\omega_j+\frac{\lambda}{2}(\sum_{i=1}^{n}\omega_j^2-1) \tag{20}$$

Among them, $\sum_{j=1}^{n}\omega_{\mathrm{j}}^2=1$,And take the partial derivative of $\lambda,\omega_{\mathrm{j}}$ in equation (20)

$$\begin{cases}\dfrac{\partial L(\lambda,\omega_j)}{\partial\omega_j}=\sum_{i=1}^{m}\sum_{k=1}^{m}d(E_{kj},E_{ij})+\lambda\omega_j=0\\ \dfrac{\partial L(\lambda,\omega_j)}{\partial\lambda}=\dfrac{1}{2}(\sum_{j=1}^{n}\omega_j^2-1)=0\end{cases} \tag{21}$$

The weight is obtained as follows

$$\omega_j=\frac{\sum_{i=1}^{m}\sum_{k=1}^{m}d(E_{kj},E_{ij})}{\sqrt{\sum_{j=1}^{n}(\sum_{i=1}^{m}\sum_{k=1}^{m}d(E_{kj},E_{ij}))^2}} \tag{22}$$

Finally, normalization is carried out

$$W_A=\omega_j^*=\frac{\omega_j}{\sum_{j=1}^{n}\omega_j} \tag{23}$$

5.1.2 Interval fuzzy entropy weight method

Entropy weight method is an objective weighting method introduced by Shannon with information technology. Its principle is as follows: according to the variation degree of each index, entropy weight of each index is calculated by using information entropy, so as to obtain relatively objective index weigh.[4]

1.Establishing interval fuzzy evaluation matrix

Evaluate the elements of the influencing factor set $X=\{x_1,x_2,...,x_n\}$,For A certain factor x_i of A, the degree of y_j's belonging is expressed by the interval fuzzy number, so as to obtain the interval fuzzy mapping:

$$\boldsymbol{f}:\rightarrow IF\left(\boldsymbol{Y}\right) \tag{24}$$

$$\boldsymbol{x}_i\mapsto\boldsymbol{f}\left(\boldsymbol{x}_i\right)=\left(\left[r_{i1}^-,r_{i1}^+\right],\left[r_{i2}^-,r_{i2}^+\right],...,\left[r_{im}^-,r_{im}^+\right]\right) \tag{25}$$

Where, $IF(Y)$ is the interval fuzzy set of all on Y, and the interval fuzzy evaluation matrix of the set of influencing factors is assumed to be:

$$\boldsymbol{R}_A^{(i)} = \begin{bmatrix} \left[r_{11}^{(i)-}, r_{11}^{(i)+}\right] & \left[r_{12}^{(i)-}, r_{12}^{(i)+}\right] & \cdots & \left[r_{1m}^{(i)-}, r_{1m}^{(i)+}\right] \\ \left[r_{21}^{(i)-}, r_{21}^{(i)+}\right] & \left[r_{22}^{(i)-}, r_{22}^{(i)+}\right] & \cdots & \left[r_{2m}^{(i)-}, r_{2m}^{(i)+}\right] \\ \vdots & \vdots & \vdots & \vdots \\ \left[r_{n_i 1}^{(i)-}, r_{n_j 1}^{(i)+}\right] & \left[r_{n_i 2}^{(i)-}, r_{n_i 2}^{(i)+}\right] & \cdots & \left[r_{n_i m}^{(i)-}, r_{n_i m}^{(i)+}\right] \end{bmatrix} \tag{26}$$

2.Determination of evaluation index weight

The fuzzy set between districts is $A = \{x_i | x_i = [u(x_i), v(x_i)]\}$,get fuzzy entropy

$$E(x_i) = \frac{1}{n}\sum_{i=1}^{n} \frac{1-\left(u_A(x_i)+v_A(x_i)-1\right)^2 + 2\left(v_A(x_i)-u_A(x_i)\right)^2}{2-\left(u_A(x_i)-v_A(x_i)\right)^2 + \left(v_A(x_i)-u_A(x_i)\right)^2} \tag{27}$$

Formula (11) can be used to get the entropy of each fuzzy number in the fuzzy evaluation matrix. Finally, formula (12) can be used to determine the weight of each factor.

$$W_Z = \omega_j = \frac{1-\frac{1}{m}\sum_{i=1}^{m} E_{ij}}{\sum_{j=1}^{n}\left(1-\frac{1}{m}\sum_{i=1}^{m} E_{ij}\right)}, \left(i = 1,2,\cdots, \ m; j = 1,2,\cdots,n\right) \tag{28}$$

5.1.3 The principle of minimum information discrimination is used for combination weighting and the final score is obtained

The weights obtained by the above two methods are substituted into Equation (26), the identification information of indicators is calculated respectively, and the principle of minimum identification information is used for comprehensive weight calculation. The objective function equation (27) is established for discrimination. [5]When the sum of the two identification information is the lowest, the comprehensive weight is the closest to the combined weight.

$$I(q(x), p(x)) = \sum_{i=1}^{k} q(x)\log\frac{q(x)}{p(x)} \tag{29}$$

$$\begin{aligned} \min F &= I(W_Z, W_A) + I(W_Z, W_S) \\ &= \sum_{j=1}^{n} W_Z\left[\ln\frac{W_Z}{W_A}\right] + \sum_{j=1}^{n} W_Z\left[\ln\frac{W_Z}{W_S}\right] \end{aligned} \tag{30}$$

Among them, the comprehensive weights W_Z meet $W_1 + W_2 + ... + W_n = 1$, and $W_1, W_2, ..., W_n > 0$ .The Lagrange function is used to solve the objective function, so W_Z can be finally solved.

$$W_Z = \frac{\sqrt{W_A W_S}}{\sum_{j=1}^{n} \sqrt{W_A W_S}} \tag{31}$$

Finally, the final grade score can be obtained through the following formula $Grade$.

$$Grade = A * W_Z \tag{32}$$

5.2 Solution of model

This paper assesses the future drought losses in India,the index system of evaluation was established by collecting the corresponding literature data, and the corresponding prediction was finally made according to the drought affected data of the country over the years through the model in the first question, and the prediction examples were obtained, as shown in the following Table 5.2.1.

Table 5.2.1

Primary indicators	Secondary indicators	Risk level					
		Micro disaster [0,0.2]	Minor disaster [0.2,0.4]	Medium disaster [0.4,0.6]	Major disaster [0.6,0.8]	Catastrophe [0.8,1]	Forecast example
drought	Normalized precipitation index	>-0.5	-1.5~-1.0	-2.0~-1.5	-2.5~-2.0	<-2.5	-1.7
	Temperature humidity coefficient	1.0~0.60	0.60~0.40	0.40~0.20	0.20~0.10	<0.10	0.50
Vulnerability of bearing body	Percentage of drought affected area of crops%	5~20	20~30	30~40	40~50	>50	35
	flood-hit population(ten thousand)	5~10	10~15	15~20	20~25	>25	17
	soil moisture content	16~20	13~16	10~13	6~10	<5	14
	GDP per capita (dollar)	>8000	6000~8000	4000~6000	2000~4000	<2000	5000
Backgr	Reservoir storage (1000 m^3)	>100	60~100	30~60	1~30	<1	45

ound of pregnancy disaster	Agricultural output value (100 billion)	>50	40~50	30~40	20~30	<20	38
	Urban drought water shortage rate%	5~10	10~20	20~30	30~40	>40	32
	Vegetation cover%	3~10	10~25	25~50	50~75	75~100	40
Drought prevention and disaster reduction capacity	Per capita disposable income	>10000	5000~10000	2000~5000	1000~2000	<1000	1500
	Number of beds per 1000 people	>6	4.8~6	2.3~4.8	1.5~2.3	<1.5	3.3
	Total financial revenue hundred million)	>2500	2000~2500	1000~2000	500~1000	<500	2100
	Annual water consumption per capita (m^3)	>400	300~400	200~300	100~200	<100	500
	Number of medical staff in each hospital	>20	16~20	12~16	6~12	<6	10

The results obtained after the above fuzzy normalization of the predicted instance data are shown in Table 5.2.2 below:

Table 5.2.2 Fuzzy Normalization Table

Index	Membership						
	Very safe	Safer	Safe	Dangerous	Very dangerous	Example	
v_{11}	0~0.09	0.09~0.32	0.32~0.55	0.55~0.77	0.77~1	0.43	0.51
v_{12}	0~0.42	0.42~0.63	0.63~0.84	0.84~0.95	0.95~1	0.56	0.6
v_{21}	0~0.23	0.23~0.38	0.38~0.54	0.54~0.69	0.69 ~1	0.4	0.45
v_{22}	0~0.14	0.14~0.29	0.29~0.43	0.43~0.57	0.57~1	0.33	0.38
v_{23}	0~0.24	0.24~0.41	0.41~0.59	0.59~0.82	0.82~1	0.36	0.39
v_{24}	0~0.46	0.46~0.62	0.62~0.77	0.77~0.92	0.92~1	0.65	0.7
v_{31}	0~0.88	0.88~0.93	0.93~0.96	0.96~0.97	0.97~1	0.93	0.94

v_{32}	0~0.33	0.33~0.50	0.50~0.67	0.67~0.83	0.83~1	0.56	0.64
v_{33}	0~0.09	0.09~0.27	0.27~0.45	0.45~0.64	0.64~1	0.5	0.62
v_{34}	0~0.07	0.07~0.23	0.23~0.48	0.48~0.74	0.74~1	0.34	0.42
v_{41}	0~0.51	0.51~0.77	0.77~0.92	0.92~0.97	0.97~1	0.93	0.95
v_{42}	0~0.44	0.44~0.58	0.58~0.86	0.86~0.94	0.94~1	0.67	0.73
v_{43}	0~0.18	0.18~0.36	0.36~0.71	0.71~0.89	0.89~1	0.24	0.32
v_{44}	0~0.10	0.10~0.36	0.36~0.62	0.62~0.87	0.87~1	0.05	0.09
v_{45}	0~0.37	0.37~0.52	0.52~0.67	0.67~0.89	0.89~1	0.74	0.86

Weight determination of maximum deviation and weight calculation of interval entropy weight method were carried out respectively by Excel and Matlab, and then the two weights were combined with the principle of minimum information discrimination to obtain new weights. The results are shown in the following Table 5.2.3:

Table 5.2.3 Weight table

	Deviation method	Entropy weight method	Combination weighting
Primary weight	0.263	0.1297	0.1876
	0.2351	0.2416	0.242
	0.2377	0.3039	0.2729
	0.2642	0.3248	0.2975
Secondary weight	0.5274	0.4962	0.5036
	0.4726	0.5038	0.4964
	0.2443	0.2427	0.2436
	0.238	0.2468	0.2424
	0.2714	0.2539	0.2625
	0.2462	0.2567	0.2515
	0.1824	0.3808	0.2703
	0.2549	0.1978	0.2303
	0.2659	0.2056	0.2398
	0.2968	0.2156	0.2595
	0.1779	0.2096	0.1933
	0.1891	0.1984	0.1939
	0.2231	0.2015	0.2123
	0.2260	0.2034	0.2147
	0.1839	0.1871	0.1857

The results of its visualization are as follows:

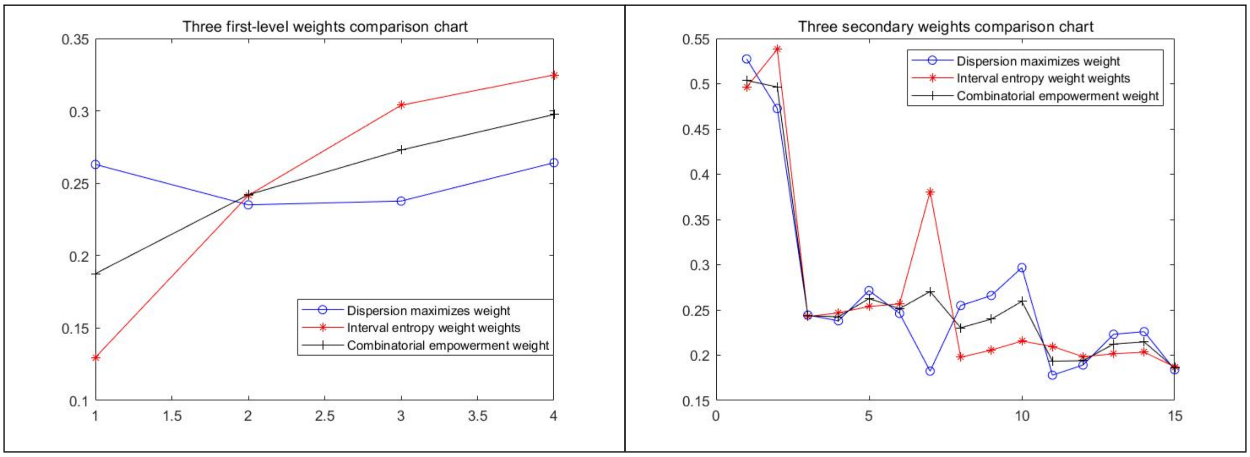


Figure 5.2.1 Comparison chart of weight between first-level index and second-level index

From the perspective of weight, we can see that the ability to prevent and reduce drought is the most important and has the most influence on the risk degree of drought, that is, the loss impact is the most serious, and prevention should be focused on, accounting for 0.2975.The second is the proportion of disaster pregnant background 0.2729, the proportion of bearing body vulnerability 0.242, and the last is the proportion of drought index 0.1876

Finally, the weight after combination weighting is obtained by formula (19) as follows:

$$Grade = A * W_Z = (0.5101, 0.5703) \tag{33}$$

The rating range is between [0.4, 0.6].Therefore, it is assessed that the country may suffer from moderate drought.Based on the weight, some prevention strategies focusing on corresponding indicators are as follows:

The measures taken for drought prevention and disaster reduction should combine the drought relief work with the adjustment of the scale, layout and economic structure of economic and social development, as well as the construction of the ecological environment. First, we should strengthen investment in water conservancy construction, consolidate and develop water conservancy projects, raise funds through various ways, and renovate, support, transform and eliminate risks and reinforce existing water conservancy projects in batches based on the operation of water conservancy projects in different regions, In order to restore and improve the irrigation benefits of existing water conservancy projects, it is also necessary to do a good job in the capital construction of farmland in combination with the construction of new countryside, improve the water storage, water conservation and drought resistance of farmland, and make full use of the limited water resources.

Secondly, we should strengthen water resources management, optimize the allocation of water resources, strengthen the unified management and scientific scheduling of water resources, ensure industrial and agricultural production and ecological water demand, and promote the sustainable development of social economy. Then we should establish and improve the drought monitoring, forecasting and early warning network system, provide reliable information for drought relief, establish and improve the drought service system, and provide high-quality services for drought relief. During drought, artificial precipitation can also be carried out to alleviate drought and reduce losses.

Then, in view of the background of disaster, we should adopt the treatment method of adjusting measures to local conditions, and take different measures to treat according to the stability, danger, impact area and financial and material feasibility of the potential disaster points. In most areas, what should be done is to maintain water and soil conservation and improve the ability to fight drought and prevent drought. The main thing is to increase green vegetation, improve water and soil holding capacity, and develop water conservation forests, which can not only prevent water and soil loss, but also change the topography and climate, and reduce the silt of downstream water conservancy projects. The increase of land vegetation and coverage can prevent wind and reduce ground evaporation, and enhance the drought resistance of the land.

6.Answer to question three

6.1 Establishment of model

6.1.1 Calculation of comprehensive disaster index of flood and waterlogging disaster based on grey relational degree

(1)Calculation of disaster factors

According to the grading standard of single index of relative disaster in the reference, the flood disaster is divided into five grades: catastrophe, major disaster, medium disaster, minor disaster and micro disaster.See Table 6.1.1 for the grading standards of each index.

Table 6.1.1 Table for the grading standards of each index.

Grade	Proportion of disaster area%	Proportion of disaster affected population%	Proportion of direct economic loss%
Catastrophe	(40,100]	(40,100]	(10,+∞]
Major disaster	(4,40]	(4,40]	(1,10]
Medium disaster	(0.4,4]	(0.4,4]	(0.1,1]
Minor disaster	(0.04,4]	(0.04,0.4]	(0.01,0.1]
Micro disaster	(0.004,0.04]	(0.004,0.4]	(0.004,0.01]

(2)Calculation of disaster index

The conversion function (34) is introduced for the proportion of affected area and population x, and the conversion function (35) is introduced for the proportion of direct economic loss y, and the grading standard in Table 1 is indexed. The flood disaster grade corresponding to the single index conversion function is shown in Table 6.1.2.

$$U(x)=\begin{cases}0.8+\dfrac{1}{300}(x-40) & 40<x\le 100\\ 0.2\lg(10^3 x/4) & 0.004<x\le 40\\ 0 & x\le 0.004\end{cases} \tag{34}$$

$$U(z)=\begin{cases}0.8+\dfrac{1}{300}(x-40) & 10<y\le 25\\ 0.2\lg(10^3 y) & 0.001<y\le 10\\ 0 & y\le 0.001\end{cases} \tag{35}$$

Grading standard of single disaster index

Table 6.1.2 The flood disaster grade corresponding to the single

Grade	Conversion function value
Catastrophe	(0.8,1.0]
Major disaster	(0.6,0.8]
Medium disaster	(0.4,0.6]
Minor disaster	(0.2,0.4]
Micro disaster	(0,0.2]

(3)Calculation of comprehensive relative disaster index

The dimensionless index sequence of each single index is used for grey correlation analysis, and the calculation model of comprehensive relative disaster index (Z) is established,The correlation degree r_{0i} is defined as comprehensive relative disaster index (Z).The calculation formula is

①Calculate correlation coefficient $\xi_{0\mathrm{i}(j)}$

$$\xi_{0\mathrm{i}(j)} = \frac{1}{1+\Delta_{0\mathrm{j}}(j)} \tag{36}$$

In the formula, $\Delta_{0\mathrm{j}}(j)$ Represents the absolute interpolation between the jth index of the comparison sequence U_{i} and the reference sequence U_0 .The greater the absolute interpolation, the greater the distance between the single index and the same index in the reference series, and the smaller the correlation coefficient; vice versa.The value interval of $\Delta_{0\mathrm{j}}(j)$ is [0,1], and the value interval of correlation coefficient is [0.5,1].

②Calculate correlation

$$r_{0\mathrm{i}} = \frac{1}{m}\sum_{j=1}^{m}\xi_{0i}(j) \tag{37}$$

The range of Z calculated is 0.5~1. The larger the index is, the more serious the disaster caused by the heavy rainfall process is. See Table 6.1.3 for the corresponding relationship.

Table 6.1.3 Grade table of Z

Grade	Comprehensive disaster index Z
Catastrophe	(0.9,1.0]
Major disaster	(0.8,0.9]
Medium disaster	(0.7,0.8]
Minor disaster	(0.6,0.7]
Micro disaster	(0.5,0.6]

6.1.2 RPI and flood disaster vulnerability curve model

Considering rainfall intensity index, coverage index and duration index, a comprehensive index (RPI) of heavy rainfall process is established[6], namely

$$RPI = I \times C \times T \tag{38}$$

The comprehensive index of heavy precipitation process is classified according to the RPI size as shown in the table, which represents the rainfall intensity index, coverage index (C), and duration index of heavy precipitation process (T).

Table 6.1.4 RPI rating table

RPI	Grade	Severe degree
$1 \le RPI \le 6$	I	Extra
$6 \le RPI \le 16$	II	Severe
$16 \le RPI \le 36$	III	*Relative*
$36 \le RPI \le 64$	IV	*Moderate*

6.2 Solution of model

In this paper, Brazil is selected as the evaluation subject for the evaluation of flood disaster losses. The results of the corresponding index calculation of the collected data are as follows Table 6.2.1:

Table 6.2.1 Indexed disaster index data

Proportion of disaster affected population	Proportion of disaster area	Proportion of direct economic loss	Proportion of comprehensive relative disaster index	RPI
0.8	0.99	0.8523	0.9954	1
0.75	0.34	0.8114	0.9448	2
0.77	0.57	0.7642	0.9179	3
0.65	0.78	0.2762	0.7983	5
0.56	0.68	0.9711	0.8408	4
0.75	0.24	0.8921	0.8000	7
0.45	0.76	0.7710	0.6715	8
0.68	0.88	0.4351	0.8125	7
0.72	0.29	0.0901	0.2027	9
0.47	0.44	0.6352	0.7892	2
0.51	0.19	0.6792	0.8033	4
0.43	0.95	0.2478	0.9888	4
0.48	0.55	0.4018	0.8847	3
0.53	0.42	0.6709	0.6677	6
0.34	0.73	0.2863	0.8924	7
0.48	0.43	0.2285	0.8411	8
0.62	0.31	0.3073	0.9245	7
0.67	0.91	0.4220	0.1771	11
0.58	0.55	0.1494	0.7761	9
0.62	0.86	0.5385	0.6811	9
0.42	0.11	0.8543	0.8202	8
0.53	0.76	0.5679	0.5722	10
0.49	0.47	0.3355	0.3435	12

Pearson correlation analysis was performed on the four loss data indicators of the indexed disaster area ratio, the proportion of the affected population, the proportion of direct economic losses, and the comprehensive relative disaster index with the heavy rainfall process composite index (RPI). The results show that the four indicators have passed the significance test at 0.05 level.

Table 6.2.2 Pearson Correlation Coefficient Table

Loss data	RPI
Proportion of the population affected	-0.807^{**}

Proportion of affected area	-0.759**
Proportion of direct economic losses	-0.491*
Comprehensive relative disaster index	-0.899**

Note: * is P<0.05, ** is P<0.01.

Therefore, the precipitation index (PRI) is finally selected as the independent variable of the disaster-causing factor. The dependent variables of the loss data include the comprehensive relative disaster index, the proportion of the affected population, the proportion of the affected area and the proportion of the direct economic loss. The precipitation index (RPI) is used as the key data of the flood intensity, and the data of the original proportion of the affected area, the proportion of the affected population, the proportion of the direct economic loss and the comprehensive relative disaster index in the process of heavy rainfall are used as the key data of the rainstorm flood damage, so as to fit the relationship curve between the flood intensity and the disaster situation of different disaster-bearing bodies, that is, the vulnerability curve.Using matlab through cftool toolbox fitting results are as follows (flood disaster vulnerability curve) :

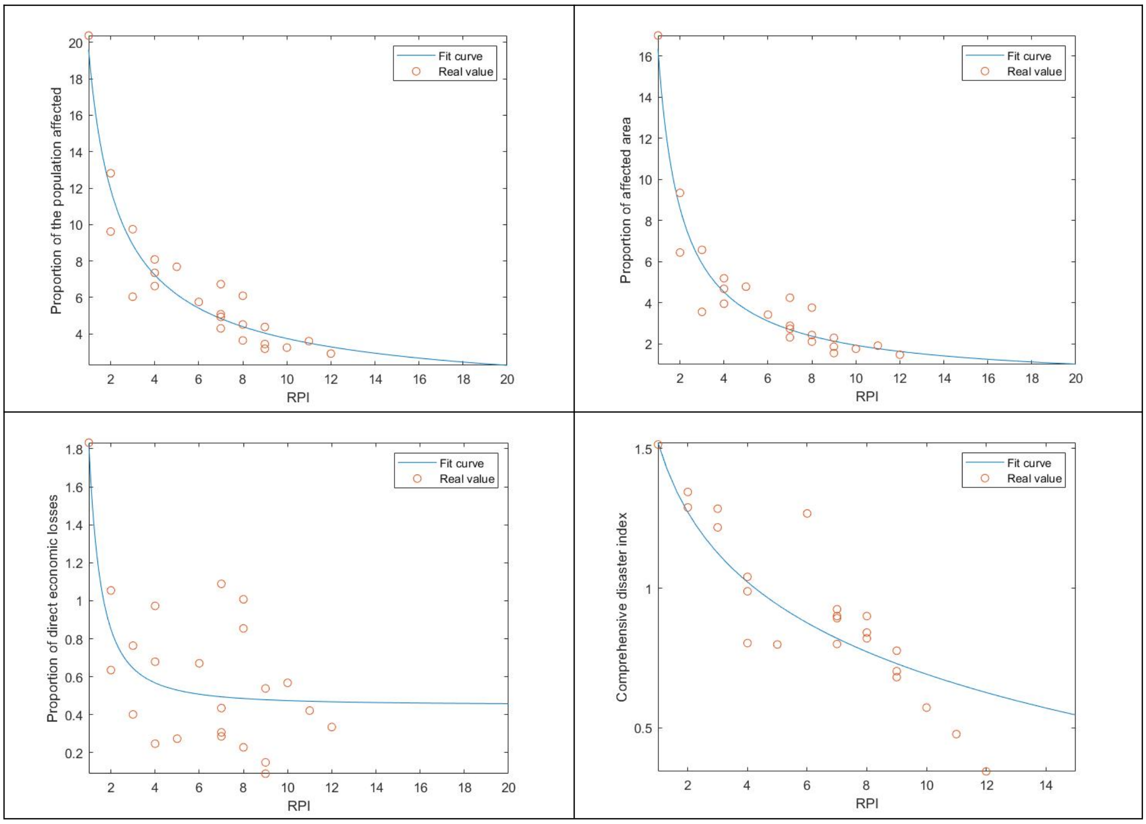


Figure 6.2.1 Flood disaster vulnerability curve

It can be seen from the figure that there is a power function relationship between precipitation and the proportion of affected population, the proportion of affected area, the proportion of direct economic losses and the comprehensive relative disaster index. The fitting equation results and coefficients are shown in Table 6.2.3.

Table 6.2.3 Fitting curve equation and equation parameters

	SSE	R^2	*DFE*	$\mathrm{Adj}R-sq$	*RMSE*	Fit curve equations
Proportion of the population affected	*28.0659*	*0.9165*	*21*	*0.9165*	*1.1561*	$y=19.6x^{-0.7187}$

Proportion of affected area	*17.5169*	*0.9308*	*20*	*0.9239*	*0.9359*	$y=15.73x^{-1.133}+1.051$
Proportion of direct economic losses	*1.7346*	*0.5129*	*20*	*0.4642*	*0.2945*	$y=1.374x^{-1.786}+0.452$
Comprehensive relative disaster index	*0.4246*	*0.7727*	*20*	*0.7500*	*0.1457*	$y=131.8x^{-0.002962}-130.2$

It can be seen from the table that the determination coefficient (R^2) of the equation is greater than 0.5, and the correlation coefficient passes the significance test at the 0.05 level, which has a high degree of fitting, indicating that the model has a good effect.We can see from the figure that the country may be affected by the level of flood disaster events identified as the most appropriate disaster, various losses will gradually decrease with the increase of the RPI index of the intensity of the precipitation process of flood disaster (that is, the severity of the disaster). The direct economic loss will be based on a stable state, that is, there will be some inevitable losses, this loss is direct and irreparable, and the comprehensive relative disaster (various relative disaster indicators), the affected area and the affected population can be reduced with the increase of the RPI index, so it can be artificially prevented to reduce various disaster losses.

Therefore, we propose some corresponding prevention strategies as follows :

The prevention and response measures for flood disasters include engineering measures for water conservancy construction, as well as non engineering measures for early warning and emergency response, mainly aiming at direct economic losses and some avoidable disasters. Strengthen the construction of levees and dams along the river, give full play to the important role of flood control levees along the river, and also build reservoirs in the upper reaches or high places of regional rivers, which can play a role in flood storage. Through reasonable flood regulation of reservoirs, flood can be discharged by shifting the peak as far as possible, which can effectively reduce the impact and pressure of flood disasters, so that the direct economic losses caused by floods can gradually become stable.

In terms of early warning, the meteorological department should pay timely attention to the rainstorm weather forecast and warning, strengthen the implementation of the regional disaster prevention and mitigation emergency system, organize more disaster prevention drills of a certain scale, strengthen the relocation of residents in low-lying areas, and strengthen the disaster prevention ability of the masses. After receiving the early warning alarm, the construction or preparation of post disaster shelters should be implemented in a timely manner. Since the measures we have taken cannot guarantee that there will be no victims, the victims should be settled in time after the flood disaster, and the reconstruction and repair of the affected areas should be carried out, so as to reduce or stabilize the losses as much as possible.

7.The report on question Four

According to the survey and analysis results, La Niña phenomenon refers to the famous climate phenomenon of the abnormal decline of the sea surface temperature in the tropical Pacific Ocean, which is characterized by the obvious cooling of the eastern Pacific Ocean, accompanied by global climate chaos, and always appears after the El Niño phenomenon.

When La Niña appears, Indonesia, eastern Australia, northeastern Brazil, India and southern Africa will have more rainfall, while eastern and central Pacific, Argentina, equatorial Africa, southeast America and other places are prone to dry early. The impact of La Niña on China's climate is mainly shown in the following aspects: China is prone to cold winter and hot summer, that is, the temperature in winter is lower than normal, and the summer is higher: the number of tropical cyclones generated and landed in China in the Western Pacific and South China Sea is more than normal.

The impact of La Niña on the global climate has caused many disasters. In order to live a normal life and minimize the harm caused by La Niña, we made a prediction of this phenomenon and designed preventive measures. The latest data from the World Meteorological Organization shows that the La Niña incident, which has lasted for a long time, is likely to last until the end of this year or even longer. This will be the Triple La Niña Event in the 21st century, meaning three consecutive La Niña winters in the Northern Hemisphere. It is understood that the winter temperature in most regions of China is relatively low, which is incompatible with La Niña. In some years, the low winter temperature will lead to the reduction of sea ice, the rise of sea temperature, and the low sea surface temperature, which will lead to the increase of sea ice in the Arctic Ocean coast, the decline of self-purification capacity of seawater and other climatic phenomena. From the global climate perspective, when El Nino occurs after La Niña in spring, the global climate system will be affected. According to the climate cycle, the La Niña phenomenon will last for a long time.

As for how to prevent La Niña event, La Niña phenomenon will often lead to global climate anomalies in a short time, which will have a serious impact on agricultural production, atmospheric circulation, oceans and the environment. In order to prevent and mitigate the abnormal climate impacts similar to El Niño phenomenon, we need to make preparations from the following aspects: first, we should strengthen climate prediction and early warning, and strengthen the prevention of typhoons, cold waves and droughts, The monitoring, forecasting and early warning of severe convection and other disastrous weather trends. Secondly, we should strengthen the early warning of weather disasters, timely release the early warning signals of heavy storm rain and low temperature rain and snow, pay close attention to the weather and climate change trends in adjacent regions and forecast regions, timely pay attention to the forecast and early warning information issued by relevant meteorological departments, and pay close attention to the early warning of equatorial Middle East and Pacific SST change trends issued by meteorological departments.

Taking the heavy rainfall in northern China as an example, the reporter learned from the China Meteorological Administration that it is estimated that the impact of La Niña in the spring of 2022 may lead to the distribution characteristics of "less rainfall in the east and more rainfall in the west" in southern China. Spring drought may occur in the Yangtze Huaihe River, southern Yangtze River and eastern South China, and the rainy season in some areas in the southwest may be ahead of schedule. There is a great possibility of mountain torrents and geological disasters, and more likely to be floods. Therefore, some measures should be taken to deal with this natural disaster, first of all, we should control the flood and implement the policy of giving priority to prevention. Improve the whole society's awareness of flood control, and turn passive disaster relief into active disaster prevention before disasters. While speeding up the construction of flood control facilities and raising construction funds through multiple channels, increase the labor input of residents: while building single water conservancy projects, set up river basin group companies to promote the comprehensive development and management of river basins; While strengthening flood control construction in lake areas and hilly areas, the development and utilization of water resources shall be standardized in accordance with the Water Law and the Regulation on the Administration of River Channels, and river management shall be strengthened and flood discharge increased in accordance with the unified planning of flood control standards.

Then governments at all levels and relevant departments should attach great importance to the protection of the ecological environment, we need to change the old "all reclamation and all production," and "indiscriminate cutting "We should take the overall situation as the priority and pay attention to the sustainable development of agriculture. Especially in the middle and upper reaches of rivers, we should vigorously carry out water and soil conservation, comprehensive management, afforestation and other work to ensure a virtuous cycle of the ecological environment. For land over reclaimed and reclaimed, we should return forest, grassland and lake in a planned and step-by-step way. Invisible reservoirs are extremely important for flood control and storage. Invisible reservoirs are special reservoirs, which are the paddy field is composed of adjacent ditches and mountain ponds. During the summer rainstorm, the paddy field, ditches and mountain ponds are used to store water, so that the paddy field can function as a temporary reservoir while exercising its normal production function. Taking Hunan Province, which was also affected by the La Niña incident, as an example, the paddy field area in Hunan Province is 26111000 hm2, while the reservoir area is only 8.22 million hm2. The paddy field area is much larger than the reservoir area. The paddy field generally cultivates rice, which can irrigate deeply, and has a good water storage function distributed at the source of rivers, which can effectively enhance the flood and drought resistance, water and soil conservation and water quality purification in Hunan Province, and enhance the stability and sustainability of the ecosystem.

Finally, due to some irresistible factors such as changes in the natural environment, in addition to resisting flood disasters, prevention is more important. Risk grade assessment shall be carried out for possible dangerous areas to form gradient grade. People's homes and towns should be built on highlands or slopes as far as possible. Class I hazardous areas are only engaged in agricultural production. In addition, agricultural production should not be promoted to intensive farming, and some important industrial enterprises for crop production with strong seasonality (avoiding flood season) and the construction of national defense and military fields should be selected, especially in areas where flood and waterlogging are difficult to occur. In the first category of areas, urban expansion should be prevented to avoid greater losses to the national economy

Contrary to the situation in the north, the situation also occurs in some parts of the world, where the possibility of fire is greatly increased due to drought. Therefore, we should focus on strengthening forest fire risk, geological disaster assessment and prevention， Under the background of frequent future fires, it is of great significance for forest fire management in various forest regions to study the impact of abnormal climate on forest fires based on models. Under the background of global warming and the increasing frequency and intensity of extreme events such as La Niña, the occurrence of fires has an upward trend. Taking the Great Khingan Mountains as an example, the fire activity in the Great Khingan Mountains is expected to increase. It is predicted that the frequency of man-made fires in the Great Khingan Mountains will increase by 72%~167% in the 1950s. Under the background of the increase of forest fires in the Great Khingan Mountains and other regions in the future, based on the types of combustibles, meteorological factors, terrain and regional fire occurrence characteristics, the use of models to simulate the probability of forest burning is conducive to determining the priority of forest protection planning activities, as well as evaluating the allocation level of firefighting resources in the study period, which is used to determine the priority of hazardous areas, It is also used to support the subsequent operation and management planning of various forest areas in the future, which can better cope with this disaster. In addition, the construction of urban infrastructure should be strengthened, focusing on the construction of shelters with strong disaster resistance. After the occurrence of geological disasters, refugees can be provided with shelters. Before the drought, water storage should be done to improve the quality of life of residents, so as to minimize the impact of losses caused by La Niña.

The emergence of La Niña will also have a negative impact on agricultural production in some areas. In order to minimize the impact of cold wave, ensure the successful completion of autumn planting task and the stable production of vegetables and other crops, it is necessary to strengthen monitoring and early warning, pay close attention to weather changes, timely communicate with meteorological, emergency management and other departments, analyze and judge the impact of cold wave weather on the production of autumn harvest crops, vegetables and other crops, organize experts to formulate and improve the prevention plan, and define the key areas, crops and periods for prevention, And put forward specific preventive measures. Pay close attention to autumn harvest and autumn planting, do a good job in cold resistance and frost prevention of vegetables and other crops, and promote the connection between production and marketing. Pay close attention to market dynamics, strengthen information monitoring on production, circulation, consumption and other links, release supply and demand information in a timely manner, guide farmers to harvest mature agricultural products in a timely manner, strive to increase market supply, guide major production areas to cooperate with large and medium-sized cities, establish stable supply and marketing channels, carry out various forms of emergency promotional activities, and promote the connection between production and marketing.

In terms of aquaculture, it is also deeply harmed by La Niña. Dissolved oxygen decreases, water quality deteriorates, frostbite is serious, and water mildew is aggravated. Large areas of dead fish are very easy to occur. In addition, the breeding period is delayed and the growth is slow. All these hazards will seriously affect the development of aquaculture. In response to this phenomenon, the following measures are taken: make good material reserves to ensure timely arrival and sufficient supply in case of emergency; Timely check and maintain relevant facilities; Strengthen the management and control of fish ponds; Improve anti stress ability; Protect liver and gallbladder, enhance nutrition, and enhance the organism immunity of aquatic animals. However, no matter how the weather develops, the majority of aquaculture people should take precautions, pay close attention to the weather changes, and use excellent nutritional products when necessary, so as to lay a solid foundation for the new year's aquaculture.

This is our report on the La Niña incident. This time, we made a detailed understanding of La Niña phenomenon and its harm through the prediction and analysis of the Triple La Niña Event, so we made the above response report. We hope that with the help of these measures, we can fight against disasters and prevent disasters and better deal with La Niña phenomenon.

8.Model evaluation

8.1 Advantages of the model

The seasonal time series model can predict the future according to the law of the development of things in the past, and has more accurate advantages for things with little fluctuation.

Using the principle of minimum information identification, the weights of the deviation maximization method and the interval fuzzy entropy weight method are combined, and the advantages of the two methods are combined to make the weights more advantageous and stable.

The construction of vulnerability curve fully reflects the relationship between disasters and loss indicators, and can make full use of effective data.

8.2 Disadvantages of the model

In terms of prediction, only the main indicators of sea surface temperature are considered, and no other indicators are combined for more comprehensive prediction.

9.Generalization and improvement of the model

9.1 Extension of the model

Compared with the rainstorm flood disaster vulnerability curve model based on the recurrence or scenario model, the time scale is more refined and can be more easily promoted in the business. In addition, if you want to involve more refined regional scale or more refined indicators, you can combine model simulation or system survey to conduct research and analysis.

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appendix

CODE:

```
%%绘制世界地图
ax = worldmap('World');
setm(ax, 'Origin', [0 0]);
land = shaperead('landareas',
'UseGeoCoords', true);
geoshow(ax, land, 'FaceColor', [0.5
0.7 0.5]);
%按照经纬度绘制点位
T=-135:1:-90;
W=10:1:55;
T2=-90:1:-45;
W2=-45:1:0;
T3=90:1:115;
W3=10:1:35;
T4=-45:1:-10;
W4=110:1:145;
T5=110:1:130;
W5=10:1:30;
W6=-30:1:-10;
W7=0:1:45;
W8=-25:1:20;
T7=35:-1:-10;
scatterm(W,T,2,'filled')  %经纬度可以
是单个点的，也可以是若干个点的
scatterm(W2,T2,2,'filled')
scatterm(W3,T3,2,'filled')
scatterm(W4,T4,2,'filled')
scatterm(W5,T5,2,'filled')
scatterm(W6,T5,2,'filled')
```

```
scatterm(T7,W7,2,'filled')
scatterm(T7,W8,2,'filled')
```

问题二：

```
%小指标权重计算
% x=xlsread('干旱数据','sheet2')

data=[new1;new2;new3;new4]

E=[]
W=[]
d=[]
[n,m]=size(data)

for i=1:2:9
    E=[E,(data(:,i)+data(:,i+1))/2]
end

for j=1:2:9
    W=[W,(data(:,j+1)-data(:,j))/2]
end

for i=1:5
    for j=i:5

dw=sqrt((E(:,i)-E(:,j)).^2+1/3*(W(:,
i)-W(:,j)).^2)
        d=[d,dw]
    end
end

sumd=sum(d,2)*2
sumall=sqrt(sum(sumd.*sumd,1))
```

```
Wj=sumd/sumall

Wj4=Wj/sum(Wj)

 %%大指标权重计算
data1=[0    0.09    0.09    0.32
0.32    0.55    0.55    0.77    0.77
1
0   0.42    0.42    0.63    0.63
0.84    0.84    0.95    0.95    1];
data2=[0    0.23    0.23    0.38
0.38    0.54    0.54    0.69    0.69
1
0   0.14    0.14    0.29    0.29
0.43    0.43    0.57    0.57    1
0   0.24    0.24    0.41    0.41
0.59    0.59    0.82    0.82    1
0   0.46    0.46    0.62    0.62
0.77    0.77    0.92    0.92    1
];
data3=[0    0.88    0.88    0.93
0.93    0.96    0.96    1.00    1.00
1
0   0.33    0.33    0.50    0.50
0.67    0.67    0.83    0.83    1
0   0.09    0.09    0.27    0.27
0.45    0.45    0.64    0.64    1
0   0.07    0.07    0.23    0.23
0.48    0.48    0.74    0.74    1
];
data4=[0    0.51    0.51    0.77
0.77    0.92    0.92    0.97    0.97
```

```
1
0   0.44    0.44    0.58    0.58
0.86    0.86    0.94    0.94    1
0   0.18    0.18    0.36    0.36
0.71    0.71    0.89    0.89    1
0   0.10    0.10    0.36    0.36
0.62    0.62    0.87    0.87    1
0   0.37    0.37    0.52    0.52
0.67    0.67    0.89    0.89    1
];
new1=zeros(1,10);
new2=zeros(1,10);
new3=zeros(1,10);
new4=zeros(1,10);
wj1=[0.5274 0.4726]';
wj2=[0.2443 0.2380 0.2714 0.2462 ]';
wj3=[0.1824 0.2549 0.2659 0.2968]';
wj4=[0.1779 0.1891 0.2231 0.2260
0.1839]';
for i=1:2
    new1=new1+wj1(i)*data1(i,:);
end
for i=1:4
    new2=new2+wj2(i)*data2(i,:);
end
for i=1:4
    new3=new3+wj3(i)*data3(i,:);
end
for i=1:5
    new4=new4+wj4(i)*data4(i,:);
end
new1
```

```
new2
new3
new4

%%利用最小信息鉴别法组合赋权
%离差最大化确定的权重
%二级指标
Wa1=[0.5274 0.4726 ];
Wa2=[0.2443 0.2380 0.2714 0.2462];
Wa3=[0.1824 0.2549 0.2659 0.2968];
Wa4=[0.1779 0.1891 0.2231 0.2260
0.1839];
%一级指标权重
WA=[0.2630 0.2351 0.2377 0.2642];
%%运用区间熵权法确定的权重
Wb1=[0.4962 0.538];
Wb2=[0.2427 0.2468 0.2538 0.2567 ];
Wb3=[0.3808 0.1978 0.2056 0.2156];
Wb4=[0.2096 0.1984 0.2015 0.2034
0.1871];
%一级指标权重
WB=[0.1297 0.2416 0.3039 0.3248];
%一级指标组合赋权
for i=1:4

S(i)=sqrt(WA(i)*WB(i))/sum(sqrt(WA.*
WB));
end
%二级指标组合赋权
for i=1:2
```

```
S1(i)=sqrt(Wa1(i)*Wb1(i))/sum(sqrt(W
a1.*Wb1));
end
for i=1:4

S2(i)=sqrt(Wa2(i)*Wb2(i))/sum(sqrt(W
a2.*Wb2));
end
for i=1:4

S3(i)=sqrt(Wa3(i)*Wb3(i))/sum(sqrt(W
a3.*Wb3));
end
for i=1:5

S4(i)=sqrt(Wa4(i)*Wb4(i))/sum(sqrt(W
a4.*Wb4));
end
S1
S2
S3
S4
S  %二级指标权重
%二级指标权重绘图
figure(1)
t=1:1:15;
W=[Wa1,Wa2,Wa3,Wa4];
Y=[Wb1,Wb2,Wb3,Wb4];
SS=[S1,S2,S3,S4];
plot(t,W,'o-b',t,Y,'*r-',t,SS,'+k-')
;
legend('Dispersion maximizes
```

```
weight','Interval entropy weight
weights','Combinatorial empowerment
weight');
title('Three secondary weights
comparison chart');
%%一级指标权重绘图
figure(2)
t=1:1:4;
plot(t,WA,'o-b',t,WB,'*r-',t,S,'+k-'
)
legend('Dispersion maximizes
weight','Interval entropy weight
weights','Combinatorial empowerment
weight');
title('Three first-level weights
comparison chart');


%%评价代码
%实例数据
%左区间
x1=[0.43 0.56 0.4 0.33 0.36 0.65 0.93
0.56 0.5 0.34 0.93 0.67 0.24 0.05 0.74];
%右区间
x2=[0.51 0.6 0.45 0.38 0.39 0.7 0.94
0.64 0.62 0.42 0.95 0.73 0.32 0.09
0.86];
%组合赋权
W2=[0.5036  0.4964  0.2436  0.2424
0.2625  0.2515  0.2703  0.2303
0.2398  0.2595  0.1933  0.1939
```

```
0.2123  0.2147  0.1857];
W1=[0.1876  0.242   0.2729  0.2975];
WA1=W2(1:2);
WA2=W2(3:6);
WA3=W2(7:10);
WA4=W2(11:15);
X1=x1(1:2)';
X2=x1(3:6)';
X3=x1(7:10)';
X4=x1(11:15)';
Y1=x2(1:2)';
Y2=x2(3:6)';
Y3=x2(7:10)';
Y4=x2(11:15)';
%左端点
y1=WA1*X1;
y2=WA2*X2;
y3=WA3*X3;
y4=WA4*X4;
%右端点
yy1=WA1*Y1;
yy2=WA2*Y2;
yy3=WA3*Y3;
yy4=WA4*Y4;
%%最终评分
XX=[y1 y2 y3 y4]';
YY=[yy1 yy2 yy3 yy4]';
YY1=W1*XX;
YY2=W1*YY;
%%
t=1:1:15;
```

```
plot(t,x1)


问题三：
R=xlsread('RPI 数据','3')
RPI=R(:,5);
ZAIREN=R(:,1);
ZAIMIAN=R(:,2);
JINGJI=R(:,3);
ZHISHU=R(:,4);
cftool
x=1:1:50;
figure(1)
fplot(@(x) zhishu(x),[1 15]);
hold on
plot(RPI,ZHISHU,'o')
hold off
figure(2)
fplot(@(x) zairen(x),[1 20]);
hold on
plot(RPI,ZAIREN,'o')
hold off
figure(3)
fplot(@(x) zaimian(x),[1 20])
hold on
plot(RPI,ZAIMIAN,'o')
hold off
figure(4)
fplot(@(x) jingji(x),[1 20])
hold on
plot(RPI,JINGJI,'o')
hold off
```