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2015 Mathematical Contest in Modeling (MCM) Summary Sheet

Turn unsustainability into sustainability

A judging system that determine when and whether a country is sustainable or not can provide reference for making a reliable development plan.Based on the definition of sustainable development given,we choose 11 indexes reflecting economical,social, cultural, the technical issues to act the model.

We build a country-comprehensive scoring model by combining grey relational analysis and cluster analysis to build the system.Then,enlarging the sample by RBF neutral network and using this system to train the BP neutral network to score a country we selected.

For task 1,7 countries are picked out according to the development degree from 3 levels.The data of each index of these countries in 2010-2012 are normalized to be analyzed by using grey relational analysis. Score these countries and we will get a series of scores between 0 and 1. The conclusion is:if the score gets higher than 0.45,the country worth a sustainable plan;

For task 2,we choose Bangladesh as the example.It gets the point of 0.3029,lower than 0.45.Ground on the 3 cluster center values,our plan are divided into 3 parts for the first 5 years,the following 10 years,and the next 5 years.On the first stage,we aim at those indexes which get lower score than the 3rd cluster center value such as Per capita forest area and Oil,then raise these values up to the 3rd cluster center value.After the implementation of the plan,the country score reaches 0.3349.On the second stage,we consider not only those indexes' scores lower than 2nd cluster center value like Per capita output of grain,but also care the index which didn't 'make great progress' after the first stage plan like Oil. We get 0.4014 by this stage.On the last stage,we focus more on the comprehensive improvement of all the indexes,especially the Crime rate.The final score is 0.4588 after the long term and it is higher than 0.45.

For task 3,sensitively analysis performs well in studying the influence on the country score when a index value floats slightly.We find that Per capita forest area contributes to the score when it increases to some extents.To rise the country score at the early stage,we can encourage the investment on forest planting.However,a extreme point exists when mentioned the contribution of Bio-capacity/Ecological footprint to the score.The score will decrease as the point gets higher than the extreme point.In a word,it will prevent the sustainable if we pay attention to the environment protection only without considering the development of industry and agriculture.It's necessary for us to improve other indexes value for the reason that they help to increase the final score.We reflect the interaction between outside factors and the indexes we got above such as natural disasters influence the Per capita output of grain.These factors have definitely different influence on the final score.

For task 4 and in the end,we discuss the strengths and weaknesses of our model for a further improvement.

Contents

I. Introduction

1.1 Problem Background

Sustainable development is defined by the 1987 Brundtland Report as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs[1]." Decreasing personal poverty and vulnerability, encouraging economic development, and maintaining ecosystem health are the pillars of sustainable development. To help an undeveloped country in a sustainable way is the aim of ICM. Judging a country whether it is sustainable, then give a hand selectively in the next 20 years, may do help to these countries.

We face mainly four problems:

- Articulate our own metrics and development a mathematical model for the sustainability.Define when and how a county is sustainable or unsustainable.
- According to our model and previous research, create a 20 year sustainable development plan for a Least Developed Country (LDC) to move towards a more sustainable future.
- Considering additional environmental factors, evaluate the effect and predict the change for the LDC.
- Analyze the influences of the parameters, then discuss the strengths and weaknesses of our model and whether it could be applied into wide fields.

II. Symbols, Definitions and Assumptions

2.1 Symbols and Definitions

Symbol	Definition
i	serial number of the selected country
m	number of the kinds of metric
$X'(j)_{\min}$	minimum value of the data belongs to NO. j metric.
$X'(j)_{\max}$	maximum value of the data belongs to NO. j metric
$X_i(j)$	processed data

$X_i^{'}$	original data
X_i	processed data
$x_0(j)$	data that describes the metric
N_i	number of vectors of the clustering block

2.2 General Assumptions

- The elements that we already have taken into consideration play a vital role in the evaluation.
- The ignored elements of sustainability do not influence the sustainability level of a country.
- The data we collected are enough and accurate,the quantification is correct.
- Our selected countries are representative and convincing to describe the sustainable and unsustainable.

III. Articulate our metrics

3.1 Collect data

According to our subjective experience and common sense, taking GDP and the scale of country into consideration, we randomly choose 7 countries and divide them into three hierarchy structure as developed country, developing country and undeveloped country.

Table 1 Chosen countries

Developed country	America Norway Switzerland
Developing country	China India
Undeveloped country	Sudan Kenya

The analysis based on 11 indexes which describe the factors gave in the task from the Internet[2-6].These data varies from year 2010-2012.In this step, we blur the

influence of time for the reason that some data can't be easily changed as the very first plan.

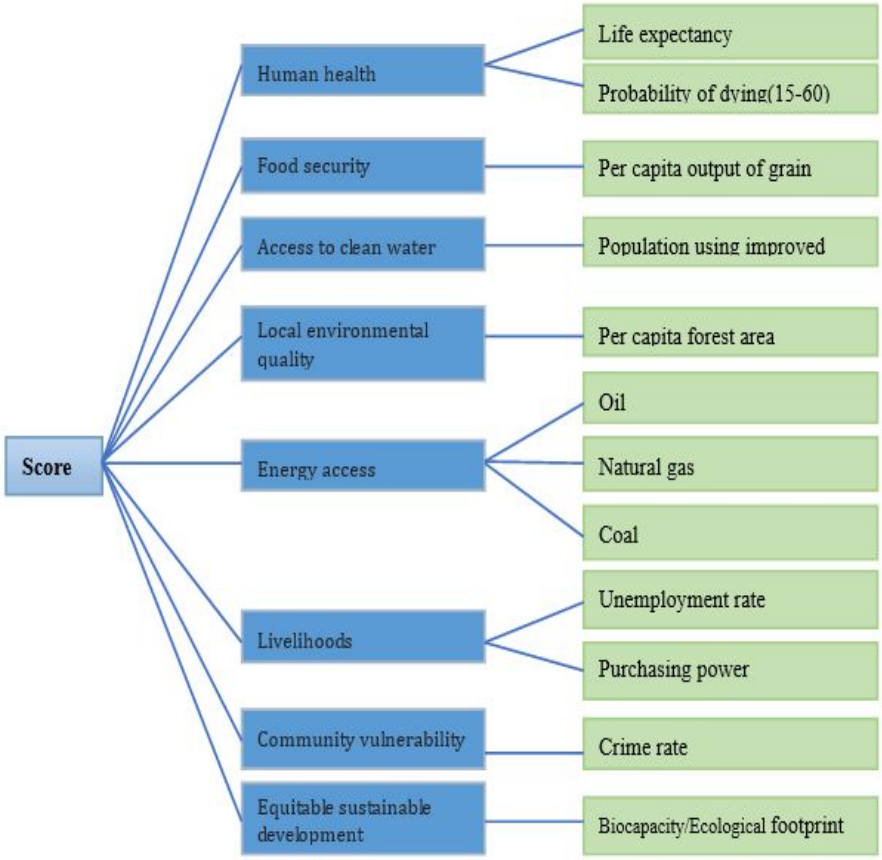

Figure 1 Index structure

Table 2 Chosen indexes

Human health	Life expectancy Probability of dying(15-60)
Food security	Per capita output of grain
Access to clean water	Population using improved drinking water sources (%)
Local environmental quality	Per capita forest area
Energy access	Oil Natural gas Coal
Livelihoods	Unemployment rate Purchasing power

Community vulnerability	Crime rate
Equitable sustainable development	Bio-capacity/Ecological footprint

We sequence these data into a matrix according to the order of the country.

In this matrix, $X_i^{'}$ are original data, X_i are processed data.The matrix is:

$$(X_1^{'}, X_2^{'}, \cdots, X_n^{'}) = \begin{pmatrix} x_1^{'}(1) & \cdots & x_n^{'}(1) \\ \vdots & \cdots & \vdots \\ x_1^{'}(m) & \cdots & x_n^{'}(m) \end{pmatrix}$$

$$X_i^{'} = (x_i^{'}(1), x_i^{'}(2), \cdots, x_i^{'}(m))^T, i = 1,2,\cdots,n$$

Where m is the number of the kinds of metric,and here $m = 7$.

$$(X_1^{'}, X_2^{'}, \cdots, X_7^{'}) = \begin{pmatrix} 78.5 & 83 & 82 & 75.5 & 66 & 63 & 60.5 \\ 103.5 & 53.5 & 58.5 & 92.5 & 101 & 120 & 284 \\ 1100 & 220 & 205.2 & 379 & 198 & 102 & 125 \\ 9.6 & 4 & 3.3 & 9 & 10.7 & 18.7 & 40 \\ 53960 & 56580 & 66520 & 11850 & 5350 & 2370 & 2250 \\ 5.2 & 0.99 & 0.65 & 1.12 & 3.4 & 3.2 & 2.8 \\ 0.14 & 0.008 & 1.96 & 0.0135 & 0.0049 & 0.037 & 0.0021 \\ 0.0028 & 0.0013 & 0.45 & 0.0025 & 0.0011 & 0.0049 & 0.0005 \\ 768.69 & 95.33 & 152.13 & 85.67 & 51.9 & 0.52 & 0.56 \\ 1001 & 164 & 2011 & 149 & 59 & 1791 & 96 \\ 0.49 & 0.24 & 0.98 & 0.45 & 0.56 & 1.41 & 0.55 \end{pmatrix}$$

3.2 Preprocess data

Making standardized treatment for these elements is of importance.We have two processing methods when faced with positive indexes and negative indexes.The calculation are as follows:

Positive indexes:

$$X_i(j) = \frac{X_i^{'}(j) - X^{'}(j)_{\min}}{X_i^{'}(j)_{\max} - X^{'}(j)_{\min}} \quad (3.1)$$

Negative indexes:

$$X_i(j) = \frac{X^{'}(j)_{\max} - X_i^{'}(j)}{X_i^{'}(j)_{\max} - X^{'}(j)_{\min}} \quad (3.2)$$

Where i represents the serial number of the selected country; $X'(j)_{\min}$ means the minimum value of the data belongs to NO. j metric. $X'(j)_{\max}$ means the maximum value of the data belongs to NO. j metric. $X_i(j)$ means the processed data.

In the following table. 'LE', 'PD', 'PO', 'PP', 'UE', 'CR', 'OR', 'NG', 'CO','WP' and 'FP' refer to life expectancy,probability of dying(15-60),per capita output of grain,purchasing power,unemployment rate,crime rate,oil,natural gas,coal,per capita forest area,Bio-capacity/Ecological footprint.

Table 3 Processed data

	US	**Swit**	**Norway**	**China**	**India**	**Sudan**	**Kenya**
LE	0.8	1	0.98	0.67	0.24	0.11	0
PD	0.78	1	0.98	0.83	0.79	0.71	0
PO	1	0.12	0.1	0.28	0.1	0	0.02
PP	0.83	0.98	1	0.84	0.8	0.58	0
UE	0.8	0.85	1	0.15	0.05	0.002	0
CR	0	0.93	1	0.9	0.4	0.44	0.53
OR	0.072	0.003	1.000	0.006	0.001	0.018	0.000
NG	0.062	0.002	1.000	0.004	0.001	0.000	0.000
CO	0.01	0.63	1.00	0.56	0.34	0.00	0.00
WP	0.48	0.05	1	0.05	0	0.89	0.019
FP	0.21	0.00	0.63	0.18	0.27	1.00	0.26

IV. Task 1:Judging a sustainable country

Since we have got some examples as illustrated,evaluating whether a country is sustainable by them is a feasible solution.Our task is to use a score system to describe the difference between different countries.Then,using the data we got to classify these countries into several levels.

4.1 Model I: Grey Relation Grade Analysis

Because of the interaction between these indexes,we finally choose Grey Relation Grade Analysis[7] as the way to confirm the score system.

4.1.1 Obtain the index weight

The concrete steps are:

Step1: To determine the reference data series as an ideal comparison standard, commonly, the value of each metric constitutes the reference sequence.

$$X_0 = (x_0(1), x_0(2), \cdots, x_0(m))$$

Step2: Calculate the absolute difference value of each evaluated object index sequence and the reference sequence of the corresponding elements,as $\Delta_i(j) = |x_i(j) - x_0(j)|$ .In

this formula, i represents the number of country; j is the number of metrics; $x_0(j)$ means the data that describes the metric.

Step 3: Confirm $a = \min_{1\le i\le n}\min_{1\le j\le m}\{\Delta_i(j)\}$ and $b = \max_{1\le i\le n}\max_{1\le j\le m}\{\Delta_i(j)\}$

Step 4: Calculate the correlation coefficient as:

$$y_i(j) = \frac{a + b\rho}{\Delta_i(j) + b\rho} \tag{4.1}$$

Where resolution coefficient $\rho \in (0,1)$,commonly using 0.5.

Step 5: Calculate the correlation degree.

$$r_j = \frac{1}{n}\sum_{i=1}^{n} y_i(j) \tag{4.2}$$

Step 6: Calculate the weight of each measure standard.

$$r_j^{'} = \frac{r_j}{r_1 + r_2 + \cdots r_m} \tag{4.3}$$

Step 7: Build the evaluation model.

$$Z_i = r_1^{'}x_i(1) + r_2^{'}x_i(2) + \cdots r_m^{'}x_i(m) \tag{4.4}$$

4.1.2 Results & analysis

Based on the data we got above,we can solve the model and obtain the following results.

Table 4 The score of each country

Country	Norway	Switzerland	USA	China	Sudan	India	Kenya
Score	0.8989	0.5766	0.4877	0.4613	0.3697	0.3172	0.08

We can see the ranking clearly by the chart below:

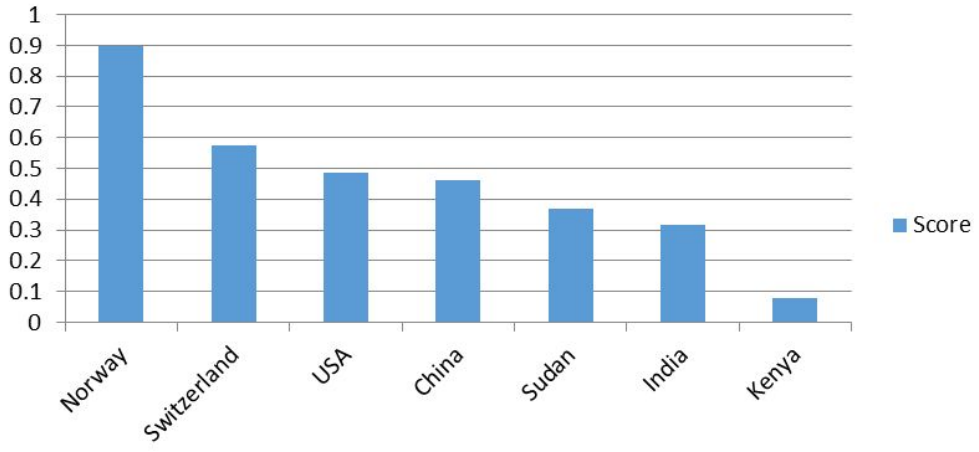

Figure 1 Ranking board

It's obvious that Norway,Switzerland ranks the first and second for their good indexes.USA,China follow then.Kenya gets the lowest score.

4.2 Model II: K-means Clustering Analysis

We get a preliminary model to evaluate the sustainable degree of these countries. For the goal of task 1,a classification of these countries is needed.K-means Clustering Analysis[8] can effectively used for data clustering and analysis of known class number m .

4.2.1 Modeling step

Step 1:Initialization

Given the number of classification and set $j = 0$ .Pick m vectors from sample vectors as $k_1^j, k_2^j, \cdots, k_m^j$,then consider them as the the clustering center $k_i^j = [k_{i1}^j, k_{i2}^j, \cdots, k_{in}^j], (i = 1,2,\cdots,k)$.

Step 2:Classification of samples

Include each sample vector $x_l = [x_{l1}, x_{l2}, \cdots, x_{\ln}]^T$ in the class which owns k_i^j as the center by this formula:

$$\left\| x_l - k_i^j \right\| = \min_{1 \le h \le m} \left\| x_l - k_m^j \right\| \quad (4.5)$$

Step 3:Center adjustment

Adjust the clustering center by

$$K_{ih}^{j+1} = \frac{\sum_{x_{l_i h} \in k_i^j} x_{l_i h}}{N_i} \quad (4.6)$$

Where N_i represents the number of vectors of the clustering block K_i^j .

Step 4:Condition judgment

Construct the objective function iteration J as:

$$J = \sum_{m=1}^{n} \sum_{x_m \in K_i} \left| x_k - k_i \right| \quad (4.7)$$

Put the data which got from Step 1 into the formula and judge the result.The iteration ends when the result doesn't have obvious change.Or $j = j + 1$ and turn to Step 1.

4.2.2 Results & analysis

We plan to classify these countries into 3 levels:sustainable,near sustainable, unsustainable.The following figures are convincing based on the data processed by the model. Here is the figures table.

Table 5 Classification

	US	**Swit**	**Norway**	**China**	**India**	**Sudan**	**Kenya**
LE	0.8	1	0.98	0.67	0.24	0.11	0
PD	0.78	1	0.98	0.83	0.79	0.71	0
PO	1	0.12	0.1	0.28	0.1	0	0.02
PPP	0.83	0.98	1	0.84	0.8	0.58	0
UE	0.8	0.85	1	0.15	0.05	0.002	0
CR	0	0.93	1	0.9	0.4	0.44	0.53
OR	0.072142	0.003007	0.999998	0.005841	0.001419	0.017904	-2E-06
NG	0.062027	0.001867	1	0.004412	0.001381	0	0.000065
CO	0.012996	0.625387	1	0.561615	0.339763	0	0.000236
WP	0.48	0.05	1	0.05	0	0.89	0.019
FP	0.21	0	0.63	0.18	0.27	1	0.26
QCL_1	**2**	**2**	**3**	**2**	**1**	**1**	**1**

QCL_1 displays the ranking result.We can easily get the classification as below:

Table 6 Classified countries

Sustainable	Norway
Near sustainable	China America Switzerland
Unsustainable	Sudan Kenya India

Conclusion:

Norway performs well in the sustainable development showed by this table.China,America,Switzerland reach the standard of near sustainable. Sudan,Kenya and India rank the lowest 3.It's hard for these countries to develop in a sustainable way.

Combined with Figure1,a demarcation line which divide sustainable country and unsustainable country can be drew. The value lies between the scores of China and Sudan which are 0.4613 and 0.3697.We want a harsh judgment to describe the difference and finally choose 0.45 as the value.

4.3 Model III: RBF&BP neural network

When mentioned a new country doesn't belongs to the table shows above ,we need another model.BP neural network is a commonly used forecasting model.However,this model needs an amount of data to train the

network.Obviously,we don't have that much data.

So we choose RBF neural network to enlarge the amount of the data we have reliably.Coming with the BP neural network trained,we can know which index impact most on the final result by a certain proportion to change values.

4.3.1 Enlarge the amount of data

RBF neural network take the advantage that it not only has the basic physiology, and the structure is more simple, but also learning faster, mainly used for function approximation and classification.

To use this model,we have to choose a learning algorithm.And we still use K-means algorithm. Determine the *h* hidden nodes of RBF neural network in the data center, and according to the determined propagation constants hidden nodes between each data center distance, then there are supervised earning output weights which by training all hidden nodes.

4.3.2 Forecast the score

We use these enlarged amount of data trained BP neural network,planning to get a correct model that can adapt our scores.Then,we use the indexes of India and Switzerland to verify whether it meets our demands.The score show that the model is of use in solving this problem.

Here is the network training error curve.

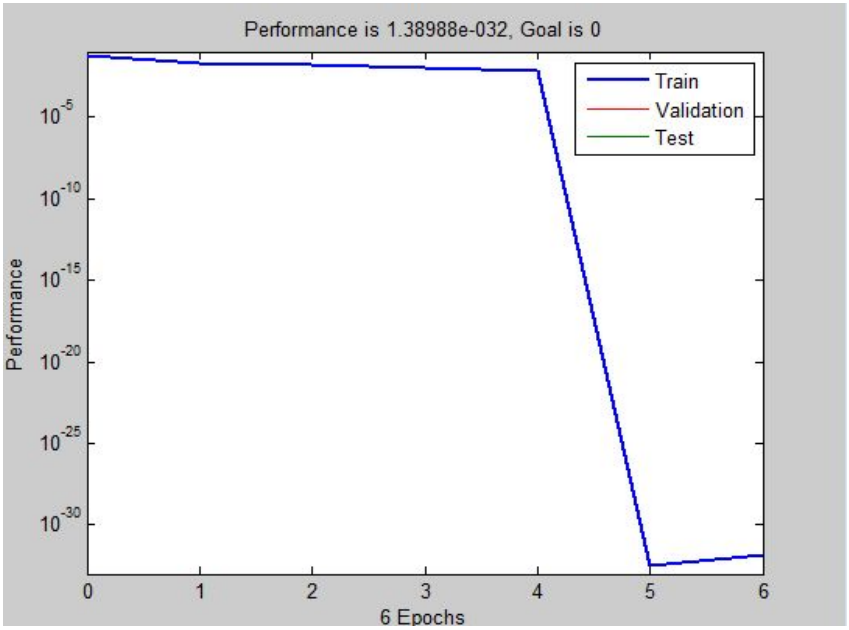

Figure 3 The network training error curve

V. Task 2:A sustainable development plan

The goal is to make a sustainable development plan for a country selected from the given 40 countries.We randomly chose Bangladesh for no reason. Evaluating the indexes by the model given above,we can get a method to sort these data and know which one contributes most to the score Approximately.According to these indexes,we may aim at different ones in different period of the next 20 years.

In order to make Bangladesh be sustainable,on the basis of our model,we formulated a development plan with three stages in the next 20 years.The establishment of three stages is based on the results of K-means Clustering Analysis.As mentioned above,we get three classifications.Combined with the specific indexes of Bangladesh,we can compare them with the results of three clusters in our model,and then make a reasonable plan.It is clearly showed in table 7.

Table 7 Cluster Centers

	Cluster1	Cluster2	Cluster3	Bangladesh
LE	0.98	0.82	0.12	0.42
PD	0.98	0.87	0.5	0.61
PO	0.1	0.47	0.04	0.11
PPP	1	0.88	0.46	0.89
UE	1	0.6	0.02	0.0087
CR	1	0.61	0.46	0.53
OR	0.99	0.027	0.0064	0.0001
NG	1	0.023	0.0005	0.0003
CO	1	0.4	0.11	0.0001
WP	1	0.19	0.303	0.0001
FP	0.63	0.13	0.51	0.37

Cluster1,Cluster2 and Cluster3 represents the 3 average scores of each level.Combined with the specific indexes of Bangladesh, we can compare them with the results of three clusters in our model, and then make a reasonable plan.

The plan is separated into 3 stages.

Table 8 The year of stage

Stage	Year
First stage	0-5
Second stage	5-15
Third stage	15-20

We make an evaluation after each stage’s implementation. If the deviation is

detected,we have to revise our plan.

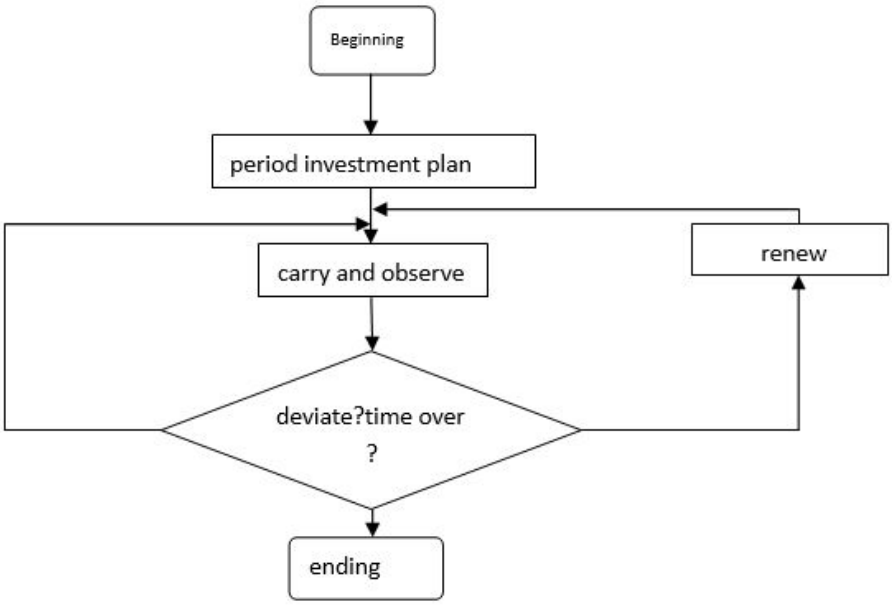

Figure 4 Flow diagram of plan

5.1 First stage

We can learn from the internet that Bangladesh is in ecological debt for its per capita forest coverage.On one hand, the small country has a population of 157.8 million, on the other hand,it is facing the problem of forest loss.Bangladesh is located in the delta which is formed by the impact of the Ganges and Brahmaputra river,it is in the northeastern part of the South Asian.During the rainy season,the vulnerable delta is easily to be attacked by floods storms and other natural disasters[9].That is why the ‘WP’, ‘CR’, ‘OR’, ‘NG’ get low scores.

So on the first stage,we need to make a plan for the problem which needs to be resolved urgently.Reducing excessive reclamation needs the support of the policy,and of course ,we must advise ICM for investing in the forest planting and high-quality dam building and so on.

From the analysis of the data,we can also know the industry falls behind for the scores of the oil and coal which are nearly reaching 0. Because of the reason and some factors we don’t know, the nation's unemployment rate is higher than a lot of countries’. For this view of point, we suggest to increase the scale of national industrial support.

We have to improve other indexes by the support in the funds, technology and policy at the same time.

Table 9 Stage 1

	Bangladesh5	percent(%)
LE	0.45	0.4
PD	0.62	0.15
PO	0.15	0.5
PPP	0.85	0
UE	0.06	2
CR	0.56	0.32
OR	0.01	7.9
NG	0.01	6.3
CO	0.01	7.2
WP	0.01	5.5
FP	0.52	1.8
Score	0.3349	12

5.2 Second stage.

If the initial plan achieved good results,we will have enough confidence in the implementation of the medium-term plan.In the scoring model that we established,the number of per capita food accounts for a large proportion.However,it gets a relatively low score.Considering the poor utilization of land in Bangladesh,it is not possible to change this situation until we invest enough fund and modern agricultural technology introduction.

But in the medium term, a lack of oil, natural gas and coal resources are still the problems we may face.For this respect,it not only depends on the input of funds, but also need to cultivate talents and the introduction of survey technology.

Table 10 Stage 2

	Bangladesh15	percent(%)
LE	0.47	0.34
PD	0.67	0.13
PO	0.23	2.1
PPP	0.82	0
UE	0.13	3.4
CR	0.59	0.02
OR	0.017	1.2
NG	0.015	0.9
CO	0.02	1
WP	0.05	1.2
FP	0.4	0
Score	0.4014	19.85

In our model, when raising the ‘PO’ index to a 0.23, ‘OR’, ‘NG’, ‘CO’ will be to 0.017,0.015,0.02, Bangladesh score will increase to 0.4044. So if the plan goes well,

Bangladesh will initially have the country's sustainable development model after the medium-term plan.

5.3 Third stage.

We have get some indexes (such as ‘WP’, ‘CR’, ‘OR’, ‘NG’) which play important roles in the sustainable development after the second stage of the plan.

So during the latter part of the investment,we need a comprehensive consideration about social, environmental and other factors in Bangladesh.We can learn from our data that the unemployment rate has been high in Bangladesh.

After we have improved agriculture and industry in first stage and second stage,the country should focus on community building, raising employment rate. It also requires appropriate welfare policies to improve the living environment for people. We find that although Bangladesh is an agricultural country, its population density is higher than any other countries’.So controlling population growth is a necessary policy on this stage.

Table 11 Stage 3

	Bangladesh20	percent(%)
LE	0.53	1.54
PD	0.72	1.32
PO	0.31	0.33
PPP	0.82	0
UE	0.22	2.03
CR	0.6	0.01
OR	0.02	0.56
NG	0.018	0.35
CO	0.03	0.43
WP	0.13	1.04
FP	0.44	0.31
Score	0.4588	14.29

In conclusion,we will see the score which Bangladesh get after the implementation of our plan reaches 0.4588.The score percentage has raised 14.29% compared with the second stage.Bangladesh meets the requirement that a sustainable country needs 20 years later.

VI. Task 3:The additional environmental factors’ influence

In this chapter, we predict the change that will occur in the next 20 years by implementing our plan. At the same time, combined with the actual

situation Bangladesh, we consider additional environmental factors including climate change, development aid, foreign investment, natural disasters, and government instability.

The contribution that external factors do to the score can be analyzed by the same steps.inhibitional effect ,climate change, natural disasters,government instability,Promoting effect development aid, foreign investment.

- Climate change

Most of the area of Bangladesh belongs to subtropical monsoon climate,Considering that our plan lasts only twenty years , we can know the influence can be ignored.

- Development aid

Bangladesh is one of the world's least developed countries, some world organizations and countries will aid in its economy, society and other aspects every year. There is a relationship between the development aid,the energy access, and livelihoods. Therefore, we can’t ignore its influence when we discussing our plan based on our model.

- Foreign investment

There are many multinational companies in Bangladesh such as Chevron, Unocal Corporation and the development situation is robust. There is no uncertainties in this aspect and we can ignore the factor.

- Natural disasters

Bangladesh suffered perennial typhoon blowing from the Indian Ocean and has a frequent natural disasters every year. It will have a large influence on food security and livelihoods, thus, we need to consider this factor into account.

- Government instability.

In recent years, Bangladesh has a stable social environment. There is no necessity taking it into consideration.

Considering these chosen metrics independently, We need to discuss the predicted results by the influence of single index when predicting the changes in the future. We select each index to determine possible changes in the short term to get the scores range. And then using BP neural network to make a prediction considering the change of index. The results are showed by figure 5.

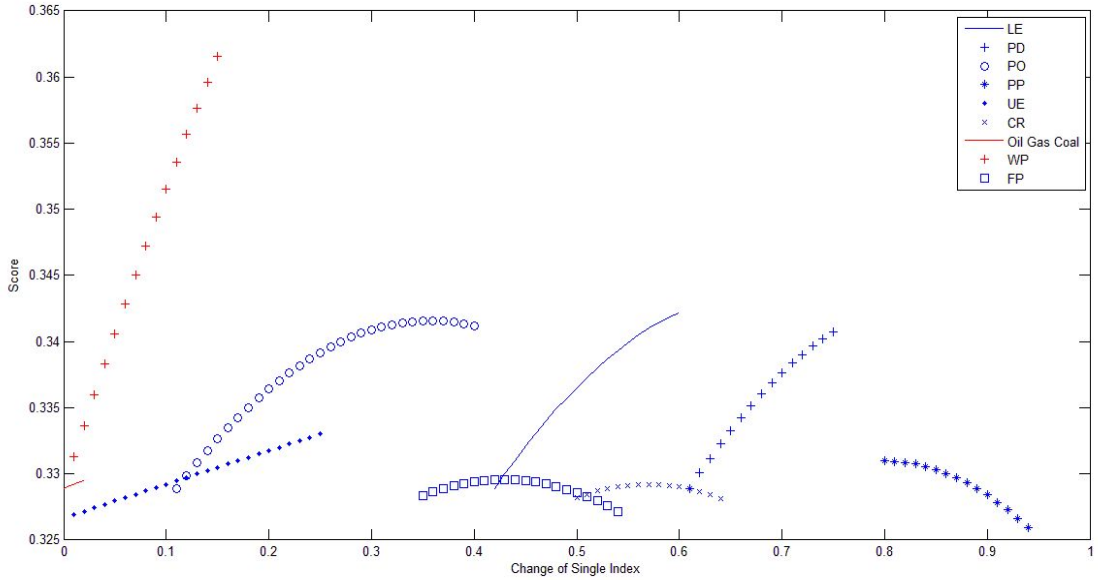

Figure5 sensitivity analysis

As we can see from figure, “WP” has a large impact on our score when it changed in small range,for “WP” gets closer to 0 in the beginning than other indexes. It verifies that our plan is accurate enough. When some indexes changed in small range,it will make a maximum value in the final score (such as ‘CR’, ‘FP’).

Through the data analysis, a low ‘FP’ (footprint) score means a weak ecological environment. It is disadvantageous for the score and the especially high score means resources are not fully utilized in the country, which is unacceptable for a country demanding to develop its economy immediately. Further, the increase of other indexes have little improvement for the development of economy.We can know that Bangladesh is on an appropriate stage of development. It is not a urgent tasks of development.

To analyze the impact of external factors that we didn’t take into account for our model results,we analyzed contacts between the changed factors and the indexes that established in our model.

For example,we experience the impact on the final score using the indexes relating natural disasters. By the data of per capita food production in Bangladesh from 2001 to 2011,we make a prediction for per capita food production. The experiment shows natural disasters and capita food production has a close relationship. It is clearly showed in figure6.

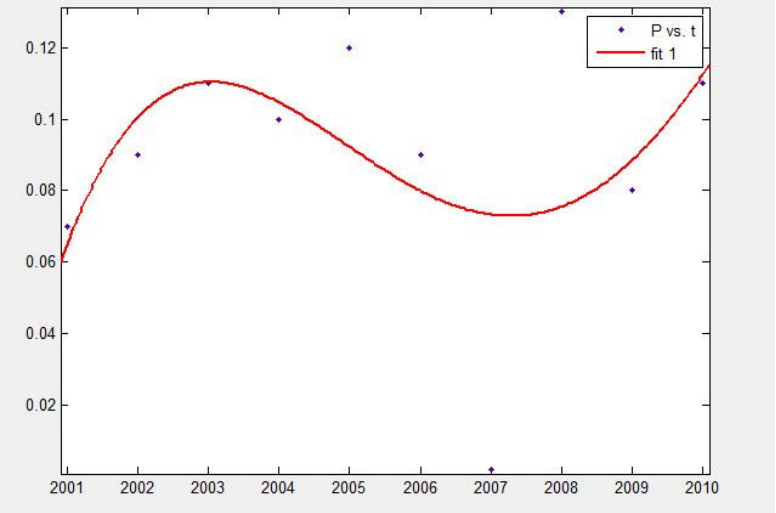

Figure 6 Per capita food

The predicted value of per capita food production in the country should be relatively stable, but as showed by the figure,it reaches the minimum value. We know Southern Bangladesh coast suffered a strong tropical storm "Sidr" in 2007. So it is easy to know that the natural disasters that impact on the final score is definitely detrimental. Considering the Bangladesh coastal location, we propose to increase funding for disaster prevention and a support is reasonable in the early stages of planning. So the weight of natural disasters impact will reduce in the future, the predictions will be more reasonable.

VII .Task4:The Strengths and Weakness

We summarizes the strengths from the application of our model,but also points out some weaknesses.

7.1 Strengths：

- The index given in the model basically can measure a country's level of sustainable development.
- The assumptions are realistic and the results are convincing.
- Based on historical data,we make reasonable predictions of the leave of sustainable development.

7.2 Weaknesses:

- We only choose 7countries as sample regions when analyzing the application of the scores.
- The prediction of score changes over time is firstly predicting the score of individual index over time, and then using BP neural network to forecast the total score, there is no good way to directly predict the score change over time.

- The effects of additional environmental factors is firstly reflecting the index changes, but not directly reflecting the total score, which makes the error of the predicted results increased.

VIII.References

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