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2016
MCM/ICM
Summary Sheet

Nowadays, water has become a more and more critical issue in global sustainable development. Through the UN water scarcity map, Shenyang is the sole heavy-overloaded city in northeast China. Moreover, there is no systematic research on water resource in Shenyang. All motivate us to explore why and how water scarcity is heavy in this city and try to get integrated solutions to this dilemma.

The project aims to mitigate water scarcity in Shenyang through build an accurate prediction and control model for future water resource situation. Based on the research outcome so far, first we widely search and collect relevant data from 2002 to 2014 independently, then sort out them into 21 kinds of Impact Factors, which has complex network relations. Hence, we must do systematic analysis and highlight main factors. Finally, in order to clearly assess the water situation in this region, we put emphasis on two key parameters: the amount of water demand and the amount of water supply.

By building BP Artificial Neural Network Model, we obtain the combined influence on supply-and-demand relatio get accurate prediction of water supply and demand in the future. Meanwhile, so as to predict every single factor without the effect by other factors and provide BP model's input layer with data, we choose the GM(1,1) model to support the project. The two models together provide reliable predictions of Impact Factors value and supply-and-demand relation in 2016-2030.

Focus on data analysis, we reach the conclusion that Shenyang will extremely lack water in 15 years,which urges us to put forward efficient solutions. Considering the “3E” principle (Equity,Efficiency,Ecology), we integrate 21 impact factors into two control factors: Environment Factor and Economy Factor. Next we control the two factors with exponential function.This step is to optimize the water supply-and-demand relationship and correct the BP model's result.

Finally, through our plan water scarcity in Shenyang could be solved in short time and water supply can always exceed water demand for decades. With stable water supply, Shenyang could smoothly achieve the national goal to revitalize Northeast China , the country's old industrial base.

Contents

1.Introduction

1.1 Background: What cause the water scarcity all over the world?

- **Natural Factors:** Climate and other geological influences are the fundamental causes of the water scarcity. Both the two factors decide how much rainfall one region can gain and store. The two influences are generally what human being cannot influence. Hence, we call them non-influenced influences.

The earth ecosystem contains many types of climates,such as marine climate, continental climate, monsoon climate, Mediterranean climate and so om. Apart from these, the zones one region lies also decide a lot. Generally, tropical zone has the most rain fall while the frigid zones have the least. However many other geological factors also mean a lot in the forming of climate, such as elevation, ocean current, monsoon. All these factors synthetically influence the rainfall the water storing.

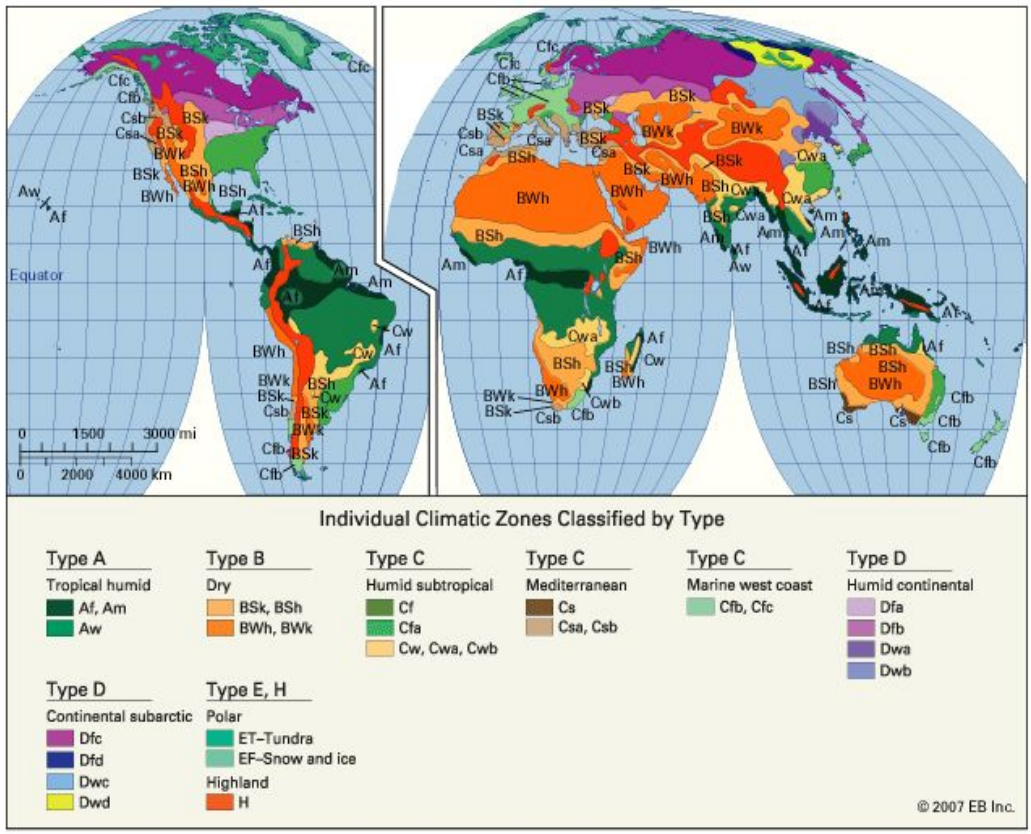

Figure 1[1]. Climate Distribution

- **Factitious Factors:** There exist other impacts which are doing more obvious influence in tens of years to water scarcity and have more to do with us human beings: the increasing population, the industrial and agricultural water use, water wasting and water pollution and so on.

Firstly, the increasing population directly aggravates the shortage of water.

[1] http://kids.britannica.com/elementary/art-95795/The-major-climatic-groups-are-based-on-patterns-of-average

More population means more necessary demand of clean water. And this factor is the biggest one causing water scarcity, especially in many developing areas.

Secondly, the development of industry and agriculture is demanding more water. And, in many cases, because of economic scarcity, we need to expand our industrial and agricultural property, which will form a vicious circle. Especially, the lack of water will limit the efficiency of production and economic scarcity usually means poor management and lack of infrastructure for water using.

Thirdly, for lack of environmental awareness and poor management of water, more and more water is being wasted in many regions. And, the inefficiency of production also causes large waste of water. Besides, in many regions, because of low lever of technology, poor law-making, lack of effective supervision system and many others causes, the pollution of water is amazing, which makes clean water is more and more valuable.

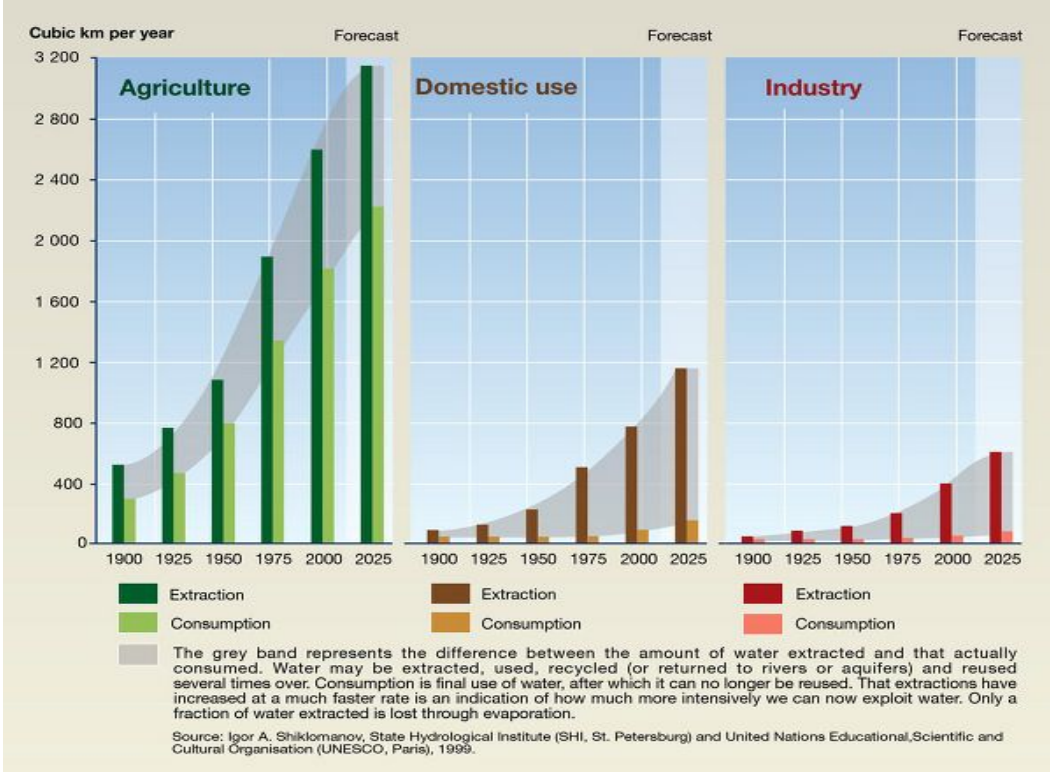

Figure 2[2]. Trends in global water use by sector

1.2 Our Goals

- Develop a model to provide a measure for a region to provide enough clean water;
- Use the model developed to show how the situation will be in 15 years in a specific region and explain how it impact the lives of natives;
- Make a plan to mitigate water scarcity and analyze its influence;
- Predict what role water scarcity will play in the future.

[2] http://www.unep.org/dewa/vitalwater/article43.html

2. Models＆Solutions

2.1 Model on Connections of Known Factors and Water Resource(Task 1)

2.1.1. Assumptions

In order to build and streamline our model, we set several reasonable assumptions based on scientific foundation.

- Except for the main parameters we investigate, the influence of other parameters about the ability of water supply and consumption is considered to remain their initial value.
- We ignore extreme weather and any other extreme and unpredictable change. Besides, we think the system we investigate is a closed self-consistent system if this assumption does not influence main parameters of this system.
- We suppose that natives' attitude towards water resource will not change obviously and the local society keep developing as its present trend.

2.1.2 Data

In order to highlight the connections that how people,natural society and the society ultimately effect on the water resource,we finally select these 21 kinds of data to carefully analysis,which are regularly used by scholars and as follows.

- Total household population: to access the region level.
- Precipitation:to simulate the natural input of water resource.
- Agricultural water consumption: to access the agriculture need of water.
- Industrial water consumption: to access the industrial need of water.
- Water pollution:to access the water pollution of the region.
- Total water consumption：to access the total need of water in the region.
- Total sewage discharge: to access the situation of pollution.
- The total length of the drain pipe/The total length of sewers
- The funds of Water conservancy, environment and public facilities management industry:to access the potential ability to deal with water crisis.
- Production capacity :to simulate the ability of water supply.
- The total length of water supply pipeline l /Total water supply:to access the conditions of hardware.
- The amount of sold water : practical water purchasing power.
- Production and operation of water
- Public service water consumption
- Household water consumption
- Other water supply
- The total number users :to simulate the water using conditions between industrial users and household users.
- The total number of household using water: to simulate the water using
- conditions of common families.

- Total number of water citizens: to simulate practical users.

In the meanwhile,we choose two vital indicators the capability of a region to provide fresh water to meet the need of people.

The amount of water demand:to account the water to keep the city iin condition .

The amount of water supply:to account the water the region can supply

2.1.3 BP Model:target on output indicators

The BP(Error Back Propagation) model has had various applications on dealing with water problem,since decades years. Yanxin[3] made the advantage of BP model to simulate the precipitation accurately.And Wang Guodong[4] estimated the water resource of Guangzhou province based on BP model,which resulted in excellent predictions.

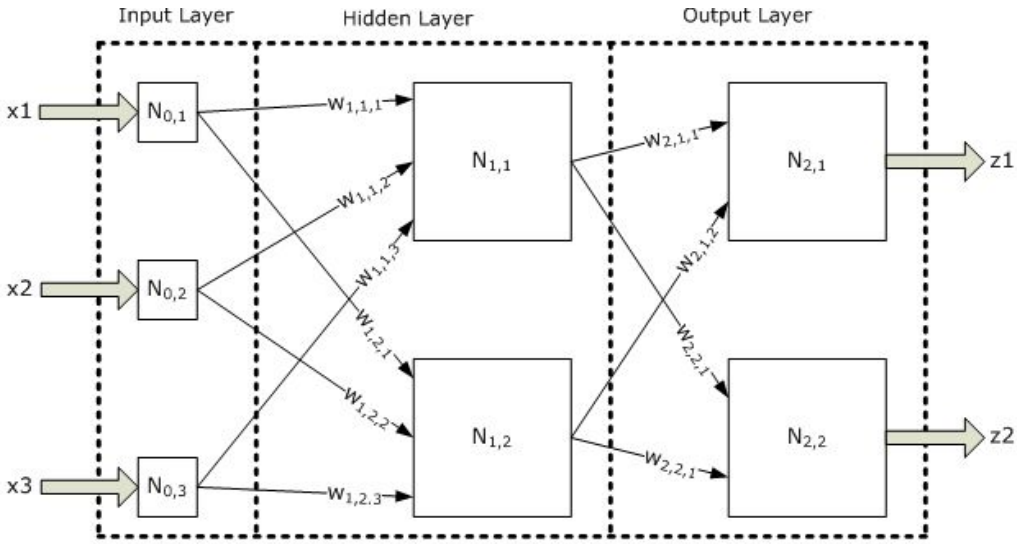

Figure 1[5]: BP model function

This model is based on such theory:it should adjust the error in the direction where the error decreases the fastest.We believe its strong learning ability is the best tool to face the challenge to build connections among interdisciplinary data and indicators.

In our paper,we select 3 layers and so the functions of network weights(ω) and threshold(B) adjustments are as follows.

$$\omega_{ij}(t+1) = -\eta \frac{\partial E}{\partial \omega_{ij}} + \omega_{ij}(t), \omega_{jk}(t+1) = -\eta \frac{\partial E}{\partial \omega_{jk}} + \omega_{jk}(t)$$

$$B_{ij}(t+1) = -\eta \frac{\partial E}{\partial B_{ij}} + B_{ij}(t), B_{jk}(t+1) = -\eta \frac{\partial E}{\partial B_{jk}} + B_{jk}(t)$$

[3] 晏欣. 灰色—人工神经网络组合预测方法在径流中长期预测中的应用研究[D]. 昆明理工大学, 2013)

[4] 王国栋. 广州市需水量预测研究[D].同济大学,2007.

[5] http://www.cnblogs.com/hellope/archive/2012/07/05/2577814.html

η is how fast the network learns.i is in input lawyer,i is in hidden lawyer,and k is in output lawyer.

In the meanwhile,based on the previous work ,we are certain that we can get reliable prediction results of the total water demand and the total amount of water supply.

2.1.4 GM(1,1) Model: target on predictions of input data

In order to get the prediction output from 2016 to 2030 based on BP model,we should first predict how each data will develop. However,simple linear programming will make horrible error. After learning that Yan[3] used GM method mixed with BP to predict data and this method greatly reduced the error,we decide to use GM(1,1) to complete this task.

Since GM(1,1) have widely used ,we will simply explain its theory.

(1)If we let $x^{(0)}=(x^{(0)}(1),x^{(0)}(2)\ldots\ldots x^{(0)}(n))\ldots\ldots\ldots\ldots\ldots\ldots(3.1.4.1)$, and then we sum them up to reduce volatility and randomness, which gets $x^{(1)}(k)=\sum_{m=0}^{n}x^{(1)}(m)\ldots\ldots\ldots\ldots(3.1.4.2)$.

(2)Then, we will build a first order differential equation：

$$d x^{(1)}/dt+ax^{(1)}=u\ldots\ldots\ldots\ldots(3.1.4.3)$$

(3)Now ,we make $B=\begin{bmatrix}0.5(x^{(1)}(1)+x^{(1)}(2))\\0.5(x^{(1)}(2)+x^{(1)}(3))\\0.5(x^{(1)}(3)+x^{(1)}(4))\end{bmatrix}$,

$Y_n=(x^{(0)}(2),x^{(0)}(3),\ldots\ldots x^{(0)}(n))'$ to solve out a by least-square method:

$$\hat{a}=(B^TB)^{-1}B^TY_n\ldots\ldots\ldots\ldots(3.1.4.4)$$

(4)And after substituting 3.1.4.4 into 3.1.4.4,we get the : $x^{(1)}(k+1)=(x^{(1)}(1)-u/a)e^{-ak}+u/a\ldots\ldots(3.1.4.5)$(we should be aware that this is an approximate formula).

(5).Finally,we will easily solve $x^{(0)}(k+1)$, by using the quation:

$x^{(0)}(k+1)=x^{(1)}(k+1)-x^{(1)}(k)$ .Above all is how we get GM(1,1).

However,we should always examine the Grey Model as following steps:

① Calculate the residual $e^{(0)}(t)$ and the relative error $q(x)$ between

$x^{(0)}, \hat{x}^{(0)}(t)$: $e^{(0)}(t) = x^{(0)} - \hat{x}^{(0)}(t), q(x) = \frac{e^{(0)}(t)}{x^{(0)}(t)}$

② Calculate the mean value $E(x^{(o)})$ and the variance s_1 of $x^{(0)}$

③ Calculate the mean value $\overline{q}$ and the relative error's variance s_2 of $e^{(0)}(t)$

④ Calculate the variance ratio $C = s_2 / s_1$

⑤ Calculate the small error possibility $P = P\{|e(t)| < 0.6745 s_1\}$

⑥ Examine the accuracy of GM(1,1).

2.1.5 Strength and Weakness

Strength: The two models:BP and GM(1,1) model are powerful tools to predict 21 kinds of data and 2 vital indicators. Moreover, we have drawn some useful conclusions about how to deal with water resource problems.

We conclude such method can fully dig out the initial connections among data seemingly without any connections.And we can simply get data without an intuitive fitting function.

Weakness: The ability prediction of BP may be reduced by too much data. GM(1,1) and BP both need serial and complete data,which are hard to collect.

The models themselves can not select data smartly,which will be all dependent on programmer himself.

2.2 Explanation on the water scarcity in Shenyang (Task 2)

2.2.1 Brief introduction to Shenyang

From the UN water scarcity map, we choose Shenyang as objective region, the capital of Liaoning province in the northeast of China.Shenyang is known as an important industrial center in China, and serves as the transportation and commercial hub of China's northeast[6]. But in this city, water is heavily overloaded and becomes the limiting constraint for development, as the picture below shows .Following are the analysis and explanation of this problem.

[6] From Wikipedia entry：Shenyang.

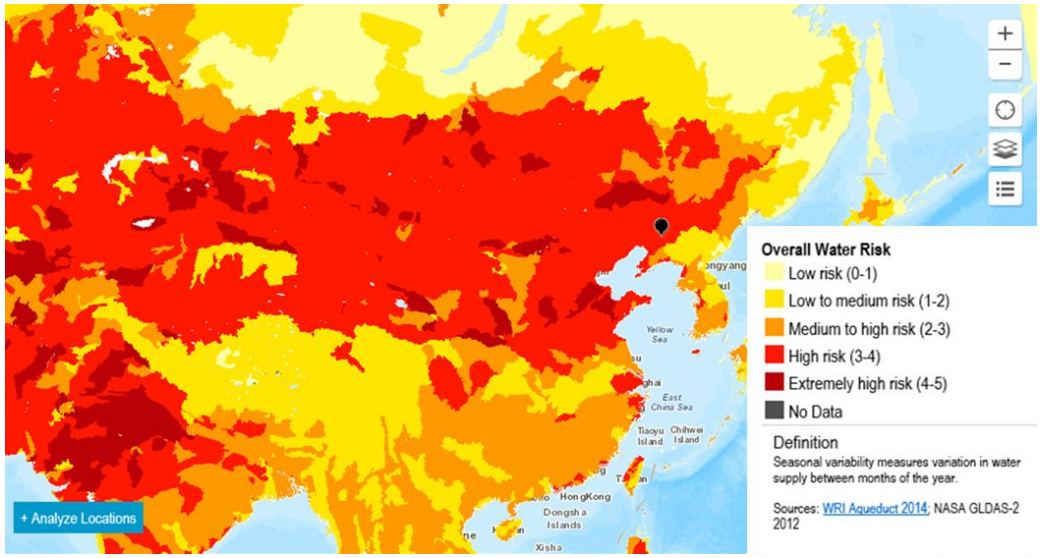

Figure 2[7]: Water Risk Atlas(the black point is Shenyang)

2.2.2 Explanation on physical water scarcity in Shenyang

From environmental perspective, Shenyang ranges in latitude from 41°11' to 43°02' N and in longitude from 122°25' to 123°48' E, and is located in the central part of Liaoning Province. Shenyang has a monsoon-influenced humid continental climate characterized by higher humidity and the majority of the year's rainfall in the summer due to the monsoon; and almost no precipitation in the winter due to the Siberian anticyclone[8]. On the one hand ,the annual precipitation in Shenyang is not stable influenced by uncertain monsoon ,usually lower than the average level of Eastern China. Especially in 2014, Shenyang suffered the worst drought in the last 63 years, mainly because of strong El Nino.Besides, the soil is tend to be harder which directly affects the rain penetration and the replenishment of ground water. All of above results in the physical water scarcity.

2.2.3 Explanation on economic water scarcity in Shenyang

From social perspective, over exploitation, waste and pollution are the critical factors. First, after 1978, there was a obvious increasing trend of groundwater depth, areas of groundwater over-exploited and funnel region. In 2002, the funnel area is 272.2 square kilometers. Groundwater over exploitation leads to the reduction of water availability and quality to some degree. Secondly, low water use efficiency and high water loss have been existing for long. For agriculture ,on

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[7] This is a screenshot of a World Resources Institute webpage (http://www.wri.org/applications/maps/aqueduct-atlas/#x=8.00&y=0.45&s=ws!20!28!c&t=waterrisk&w=def&g=0&i=BWS-16!WSV-16!SV-2!HFO-4!DRO-4!STOR-8!GW-8!WRI-4!ECOS-2!MC-4!WCG-8!ECOV-2&tr=ind-1!prj-1&l=3&b=terrain&m=group)

[8] From Wikipedia entry：Shenyang.

account of climate factor, irrigation water is needed a lot making up over half of the total water use. However, traditional irrigation method is still common and water consumption rate is up to 65 percent, nearly twice the average rate of developed countries.For industry, with the development of technology, the water consumption per 10000 yuan output value is much less than before,but the water using efficiency and utilization of circuladeting water need to be improved. And there is a wide gap between the water consumption per 10 000 GDP of Shenyang and developed cities in the world. What's more, the eco-environmental water consumption accounts for under 7% of the total every year that may do harm to the ecosystem. Thirdly, water pollution becomes a more and more serious problem. Although the western parts of the city's administrative area are located on the alluvial plain of the Liao River, the river is one of the most polluted rivers in China resulting from human activities which can't be used to drink and irrigation,even no life in it.Besides,Hun River and others also face the danger to be polluted. For agriculture, excessive use of fertilizers and pesticides pollute underground water, which can also bring about eutrophication disaster. For Industry,on the one hand, rapidly developing industry inevitably produced much effluent, because of the single-minded pursuit of profits and absence of supervision, the waste water may usually not meet the standard to discharge. On the other hand, the scientific technology is backward for sewage treatment and cyclic utilization and the cost is high. Fourthly, the need for water is continuously increasing. The population is sure to increase, especially after the abolishment of one-child policy.And urbanization is an irreversible trend in the future, so more water supply and drainage pipelines will be needed and more water will be needed. Besides, in the society , the government doesn't attach enough importance to water resource and the habit to save water isn't widely recognized among residents, moreover the water price in Shenyang ranks 14th in the fifteen Sub-provincial cities in China. All of above results in the economic water scarcity.

3.2.4 Brief summary

In a conclusion, multiple factors from both environment and society contribute to the heavy overload of water in Shenyang . Water has already become a critical issue there.

2.3 The water situation of Shenyang in 15 years (Task 3)

2.3.1 Great water crisis in Shenyang

As GM(1,1) and other prediction models shows how each data develops,we realize that Shenyang city will be absolutely trapped into the water crisis,which is called "heavy overloaded".

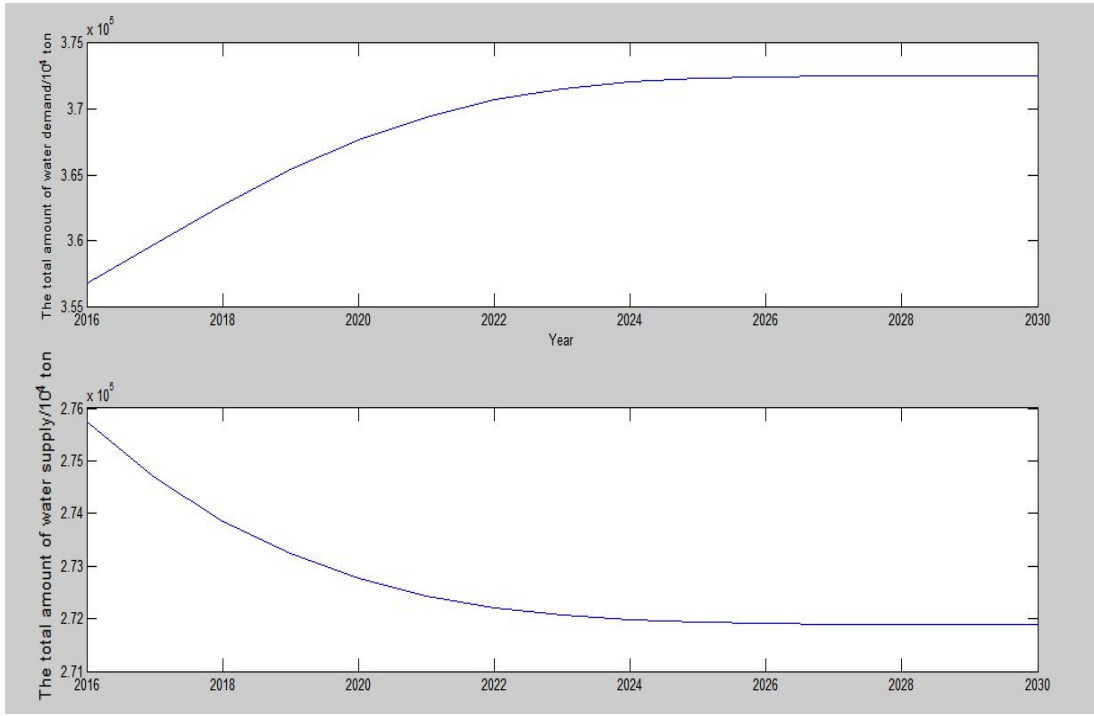

Figure 3 The prediction of the amount of the total water demand and the total amount of water supply based on BP model

The first evidence is how the amount of the total water demand and the total amount of water supply will develop. It is clear that the total water demand will greatly increase while the supply even falls down.The enormous difference decides the fate of this city,which will be trapped into “heavy overload”.

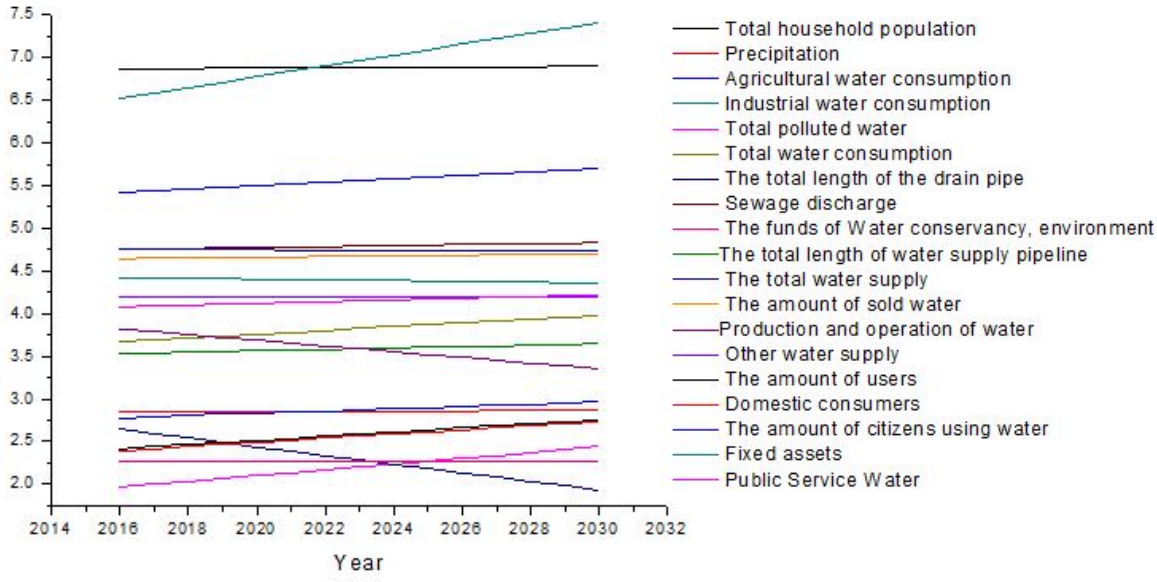

Figure 4[9] Predictions of all data based on GM(1,1) or logistic model.

[9] The data form is in the appendix.

The second evidence is a series of data predictions. From 2016 to 2030,the amount of industrial and agricultural water will reach in 5 billion tons.However the total water supply will grow up to 2.5 billion.It can not completely satisfy And among all of the supply resource,the city itself can only provide each citizen 0.5 billion,which is produced by water purification equipment and water storage.So if Shenyang can successfully provide each citizen with 276000L,which is totally 2.7 billion ton,it still demands great water supply from other resources.

And another powerful evidence is that

$I = \frac{A-B}{A}$,A is the amount of water resources,B,is the amount of used water.

Form 1 The prediction of I

year	2016	2018	2020	2022	2024	2026	2028	2030
I(%)	-28	-30.9	-33.8	-36.7	-39.7	-42.7	-45.8	-49

The prediction of I based on GM(1,1) model show that the demand of water supply will greatly surpass the amount of water supply and the ability to resist water crisis will rapidly degenerate.

2.3.2 The environmental drivers effect

Although we predict the precipitation in the next 15 years,the unbalanced season distribution and the according to Chen Wenke[10]'s study,the surface runoff is certain to decrease 10,000,000L/year. The input supply will surely add to the crisis.

The biodiversity in Shenyang can be crucially reduced.The vegetation types do not fit the situation that lack water,and the lack of water will accelerate the desertification in the western part.

2.3.2 Economic and farming problem

First,the lack of water will destroy the farming.Shenyang's main crops(corn,wheat,soybeans) corns need 45,000-60,000L[11],per ha in summer,lack of water will destroy the grain cultivation,which will cause greatly increase of price of food,and directly cause the rapid change of unemployment rate and social instability.

Second,We should point it out that Shenyang economy still heavily depends on primary industry,the great increase of agricultural water is clearly based on the current rude cultivation model.

The decrease of the total length of the drain pipe shows that the quality and amount of water purification equipment actually fall down,which indicates that the practical society still lacks the awareness and culture to save water and put it into action.

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[10] 陈文科. 转型中国水危机的多维思考[J]. 江汉论坛,2013,02:63-70.

[11] http://wenku.baidu.com/link?url=sDfYGnlhWcjtXngDn_NgCQNbQKHvsttmXqoP_tmW9vxN48hQxQEV3G8N8nA77LiJzKBoo0fIcuCD27GuG6Zm6XJQ03PNOr5HGucmo7FJu0y

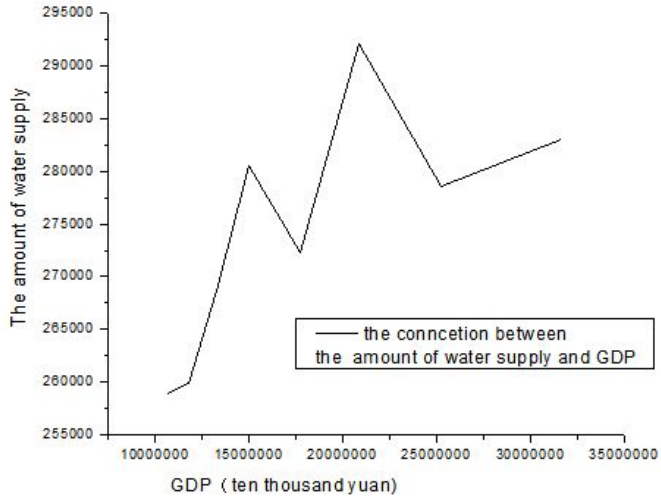


Figure 5 The relationship between GDP and the amount of water supply

As for industry the high-water-consumed factory had to reduce or stop most of production activities,the heavy industries will surely receive restrictions.

The damage will be more serious,if we consider the relationship between GDP and the amount of water supply.It's clear that GDP will fallen ,if the supply can not catch up the growing water demand.

In conclusion, we should notice that all of these will make Shenyang's terrible economy even worse.

2.3.3A citizen's life in water crisis

In the common citizen life,let's set up a virtual student,Ted.The the story begins at 2016,in this year Ted becomes a college student major in engineering,everything is normal,except that the government raises the water price.When he graduates from the college(now we are in 2020),he finds a job in a company which concentrates on saving water,while his classmates major in farming had to face crucial reality to deal with the lack of agricultural water.In 2025,filled experience in solving water crisis,Ted leads a successful life,although facing with the high price food caused by serious water crisis.Five years later(2030),Ted had to escape from Shenyang City to find a city with adequate water.

2.3.3 A fighting city

Though Shenyang city is facing serious crisis,it still digs out most of its potential water resources.

The water supply system actually keeps a slow increasing rate.Though the amount of water using citizen rapidly grow up to 926,000,the amount of water users apparently slowly increases to about 574,000.This compared data change shows that Shenyang city continues to optimize the industrial layout .And the amount of production and operation of water,the production capacity is surely to increase from 1,964,2000 to 2,092,000 m^3 /per day,we are confident that these details will ensure the feasibility of our plan.

2.4 Plan to Mitigate Water Scarcity (Task 4)

With the help of the data we have and the model developed, we can streamline our prediction about the situation of water resource in Shenyang and design an intervention plan to mitigate water scarcity in the future.

2.4.1 Parameters Brought into Consideration

- **Quantified Parameters:** population, agricultural water consumption, industrial water consumption, household water consumption, sale of water, public service water, length of water pipes, output of sewage, total ability of water supply, quantity of surface water, quantity of underground water, rainfall, recycling rate of water, investment of water conservancy project.
- **Qualitative Parameters:** official water policy, change of local industrial structure, development of water-saving technology, adjustment of water price, citizens' water-saving awareness.
- Particularly, having considered that every ecosystem is not a single and independent subject and it always has connections with many factors out of the system, so it is not closed and self-consistent actually. Hence, when making this plan, we also bring many other parts into consideration, such as interaction among systems (especially between the chosen region and its surroundings), the resource in a bigger geographical scope and the political and economic situation out of Shenyang.

2.4.2 Research on Quantified Parameters:

- **Control Model :**

First,we choose "3E" principal(Equity,Efficiency,Ecology) as the macro principal.We use it to plan the water resources logically by keeping the balance of three key elements and the macro water resources distribution.

Learning from Zhang Jihui[12]'s previous work,we refer how he simplified his optimization model and select control conditions.

The control model's target is to get optimization of the amount of water demand and supply ,so we build up: $(W_{demand}, W_{\sup ply}) = \{f(E_1, E_2)\}$.

Form 2 elements of control model

E_1	the economical element
E_2	the environmental element
W_{demand}	the total water demand
$W_{\sup ply}$	the total amount of water supply
f	The optimization relationship among four elements

[12] 张吉辉. 基于水足迹的区域广义水资源动态协调与控制[D].天津大学,2012.

And the control conditions and instructions are as follows:

1) $E_1 = \sum xy$, $E_2 = \sum mn$, x or m is the weight of each related data,y or n is the data.

2) $\sum y$ should less than the amount of water supply.

4)Each data should be controlled in proper interval(especially the amount of agricultural and industrial water).

5)When dealing with x,we should consider the uncertainty.

6) E_2 depends on the public psychological expectations,we simply suppose

$E_2 = K(1-e^{-Rt})$……(2.4.2.1).

To simplify the model,we suppose :

(1)each x is the portion among all data.And each data will change according our plan.

(2)K=1000,R=1000 in (2.4.2.1);

As for f, we should realize that this model is apparently rough.so we still choose BP model to simulate the final answer.

- **How to control this model:**

  As we have made E_2 change following the specific function, all work should concentrate on each x and y.

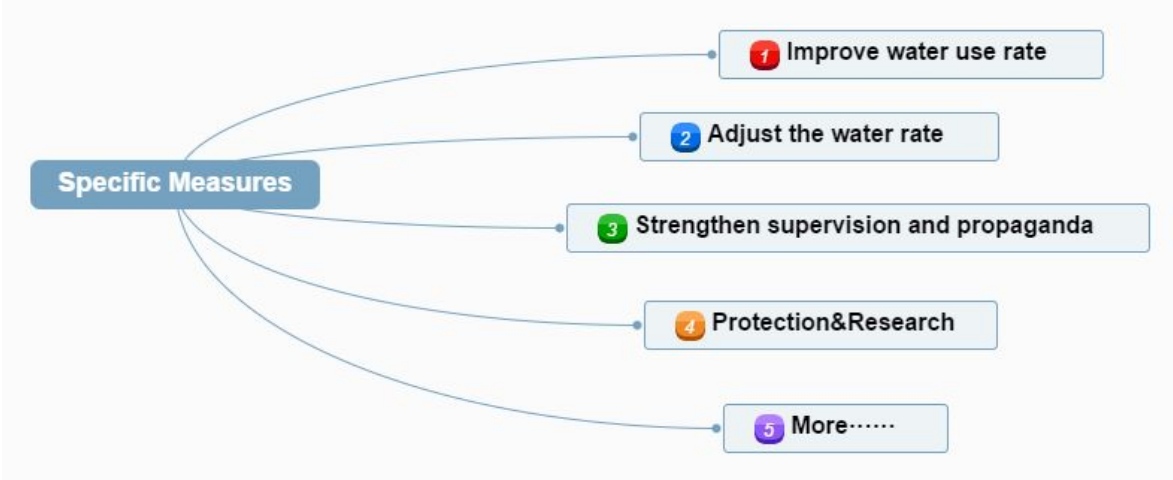
  To simply the model and follow the "3E" principal[11],the weight of all x should be up to 1/3.And all data should fall or raise logically in accordance with the plan we design.

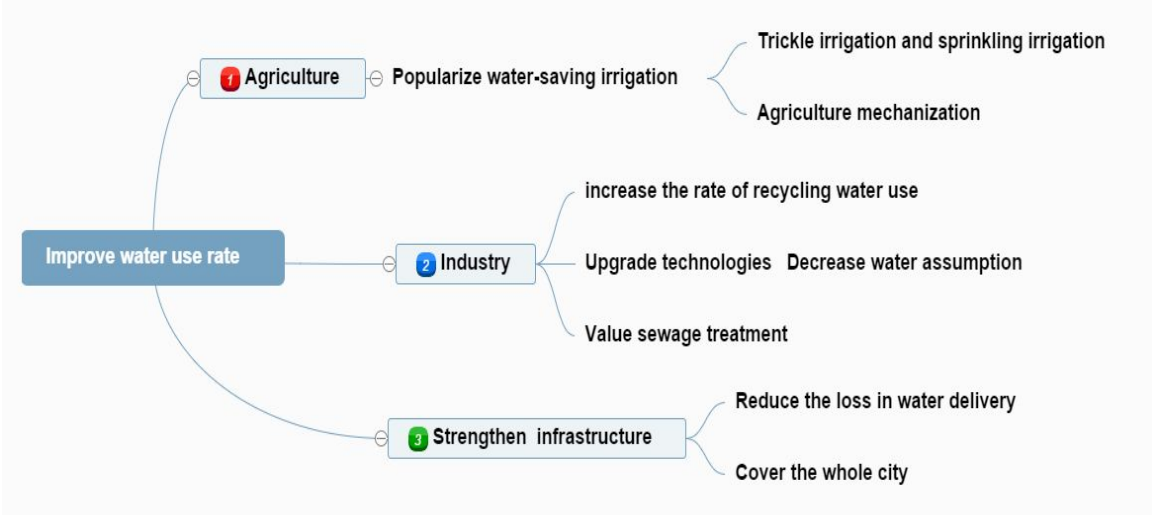
2.4.3 Analysis of Qualitative Parameters:

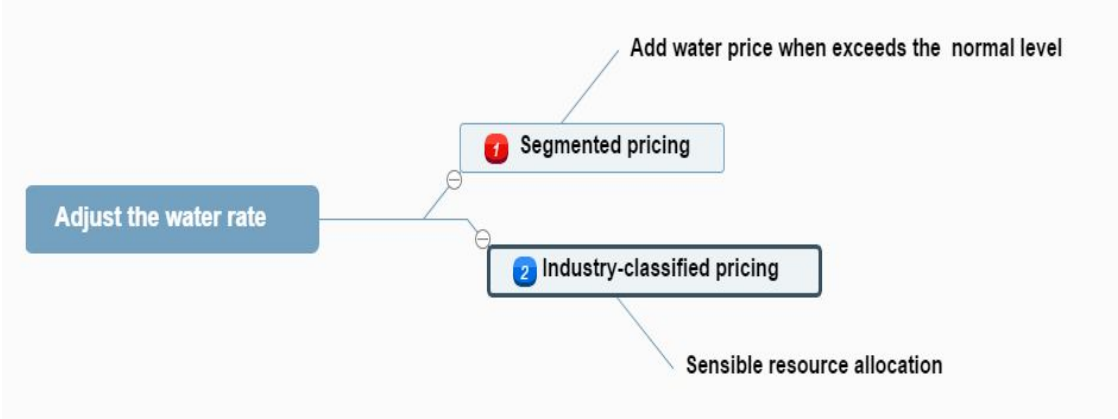
- Though the birth control has been relaxed in China, we still think population in this region is not going to experience a rapid growth. We hold the view because of two reasons:
  - Young people in China mostly hold different view about family with former generations(they do not pursue more children as soon as possible as their grandparents);
  - Natives in northeast area of China traditionally hold a indifferent attitude towards having a second child.
- Chinese government has decided to revitalize Northeast China , the country's old industrial base and Shenyang has no superb potential to develop the tertiary industry. As a result, we think in the foreseeable ten years, Shenyang government will still regards traditional industries as main economic component. And objectively traditional agriculture and industry will remain pillar industries of local economy.
- Because Shenyang is a inland city, it has poor potential to develop desalination industry to expand water supply. Meanwhile, due to the cost

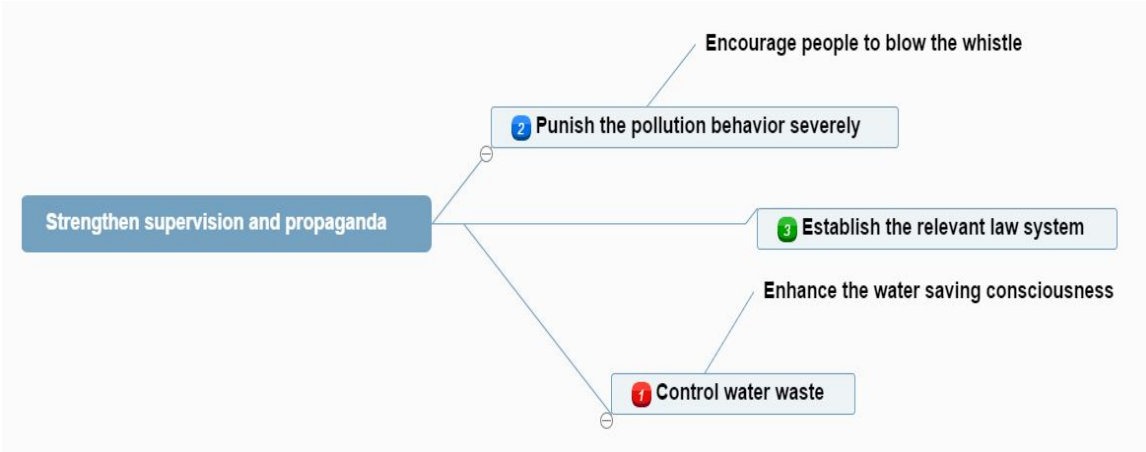
- of desalination and limitation of related technology, surrounding coastal cities also has little chance to develop extensive desalination for providing water in foreseeable years.
- Shenyang has just changed its water price in 2015, and water price is always regarded as a fundamental subtle part of citizens' lives. Hence, we believe that, without huge adjustment of policy or other extreme changes, water price cannot accept a huge change in Shenyang.
- Because NGO have limited influence in China and it is a slow process to promote citizens' attitude towards water and to have their habit changed,
- we believe that government, both local government and central government, will remain the main subject to push our measures forward in the future.
- Large-scale of reservoir construction and artificially transfer of water among different areas will influence the whole ecosystem greatly(such as to destroy land's natural ability to keep water, salinization of soil and influence local initial climate), therefore, our artificial measures cannot be carried out along with destructive effect on local and surrounding ecosystems.

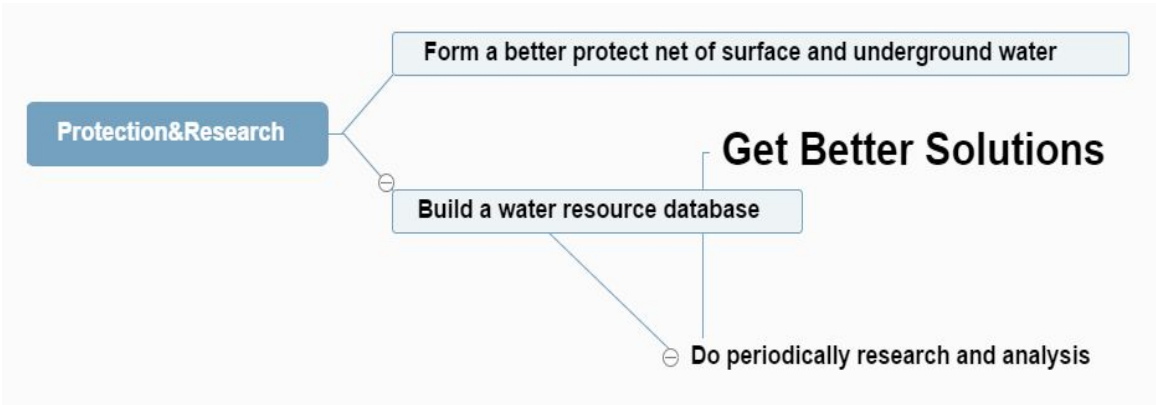
2.4.4 Specific Measures











2.5 Project water availability into the future in Shenyang

Up till now,all of the work figures out the same result: our designed plan has excellent success.The prediction results show that Shenyang city can escape from the moderately overload state and feed itself.And if Shenyang city could partly adapt our plan,the serious water crisis should be defeated in 2 years.

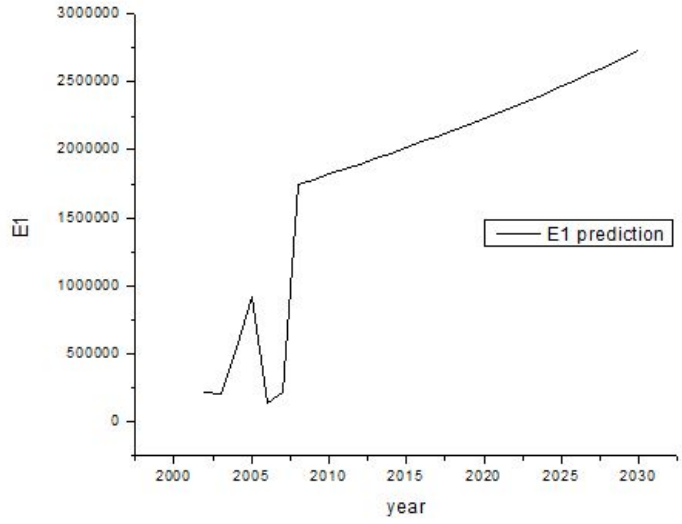


Figure 6 The prediction of E_1

The analysis of E_1 shows that the data will immediately be back to normal state in 2 years.Though the E_1 unit has no meaning,the linear change still suggests that water supply will stably supports the growth of the city after 2010.This proves that our plan can stably control selected elements in 15 years,within high anti-interference ability.

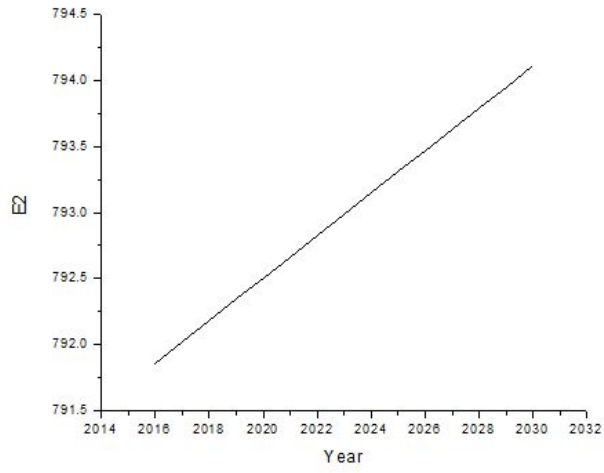


Figure 6 The prediction of E_2

Year	2016	2018	2020	2022	2024	2026	2028	2030
E_2	791.85 65385	792.18 03805	792.50 37186	792.82 65537	793.14 88865	793.47 07178	793.79 20483	794.11 28789

Form 3 The partly prediction of E_2 based on its prediction function

As the development of E_2 shows,the public psychological expectation slowly rises up,which shows that the society culture towards water protection and usage is a slow and hard process.

And the fact that 3 unit change could create great change of supply and demand shows that this element is greatly valuable,worth to study its value further.

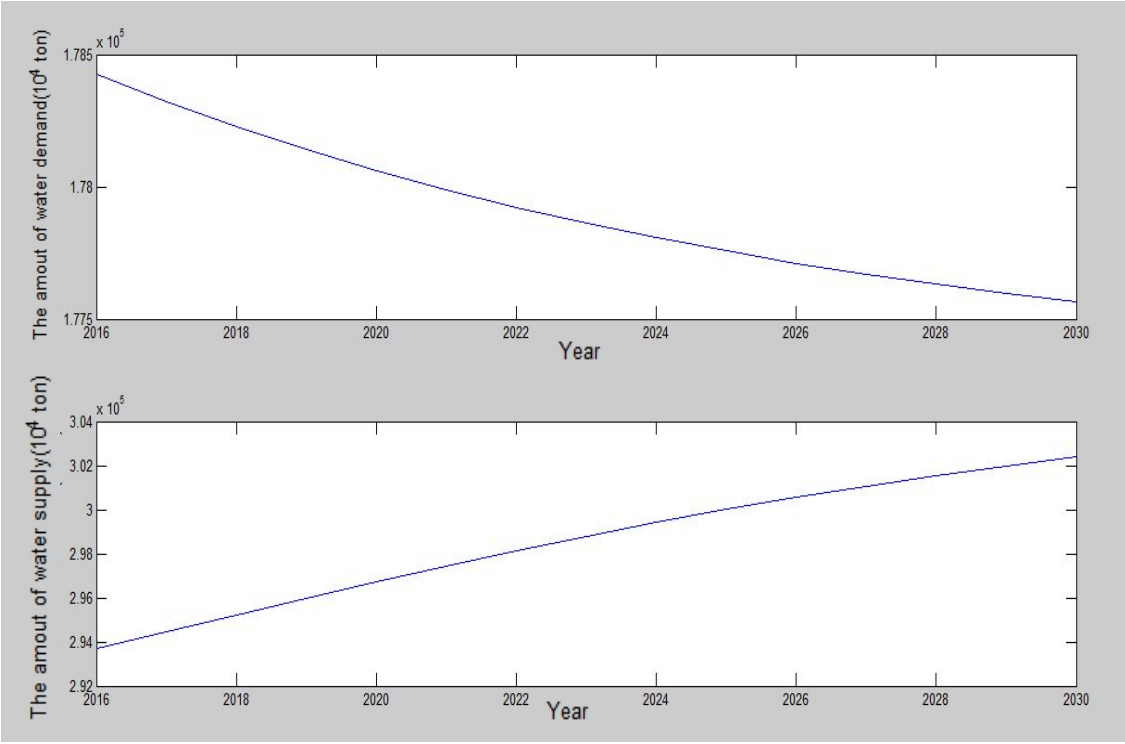


Figure 7 The prediction of the amount of water demand and supply

According to the prediction based on BP model,we get excellent results about the amount of water demand and supply.As the Figure? shows,from 2016,the amount of water demand falls down while the amount of water supply rises We also notice it that even in 2016 ,the supply has been twice than the demand .

In conclusion, our plan could target at specific elements and successfully control their development,and finally save Shenyang city.All of these should contribute to the data we collect carefully , those models we set up and all analysis work we devote to.

3.Appendix

3.1 **Data**

All data has been collected in the excel with our email.