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Industrial Structure Adjustment of Shaanxi Province under the Limited Water Resources Condition

Abstract Shaanxi Province is a region poor of water resources in China, and the lack of water resources is becoming a key factor which restricts the social and economic development of Shaanxi Province. In the perspective of efficient utilization of water resources, Shaanxi Province is committed to the transformation of the economic growth and the industrial structure, and treats these measures as important guarantees for the future development of Shaanxi Province. This paper focuses on building multi-objective programming model of industrial structure optimization under the limited water resources condition, indicates the direction of the industrial transformation and water consumption structural adjustment by solving the model, and furthermore points out the key factors that affect the development of Shaanxi Province in the future. Finally, the authors give some advices of promoting the reasonable and effective utilization of water resources of Shaanxi Province.

Keywords: water resources, capacity of water resources, industrial transformation, multi-objective programming

1 Introduction

In the recent 20 years, the most obvious feature of China's development was the ecological deterioration coming along with the economic growth. And because of this deterioration, severe ecological issues and environmental problems occurred frequently, which revealed that the way of the development of China was unsustainable. Water resource is becoming a key factor which restricts the sustainable development of the region. Water resource is a dynamic and limited natural resource while China's available water resource per capita is only a quarter of the world average. China is a typical water-strapped country (Water Resources Department of Shaanxi Province, 2008). And the over-use of water resources under the pressure of economic development has already caused many problems, such as the ground subsidence caused by over-exploration. To keep the economic growth and social stability and to improve the capacity of water resources, there is no better measure than the transformation of industrial structure and the optimization of the allocation of water resources.

Shaanxi Province is in the North-west of China, and it's a typical water-lacking area (Yu, 2011), with uneven distribution of water resources. And with the development of society and economy, the water resources capacity is declining rapidly. Therefore, it is really essential to find out a way to improve the capacity of the limited water resources so as to accelerate the sustainable development of society and economy. As there will not be massive growth of the total water resources, an in-depth research about how to transform the industrial structure, change the way of economic growth and allocate the water resources in a rational way is necessary and beneficial for the development of society and economy of Shaanxi Province.

2 The analysis of the utilization of water resources in Shaanxi Province

2.1 Water resources in Shaanxi Province

According to *The National Water Resources Planning*, which was published by the State Council, the gross amount of water resources of Shaanxi Province was only $2.841\times10^{12}m^3$, only ranked the seventeenth of all provinces in China. Besides, the amount of water resources per capita in Shaanxi Province was just 54% of the national average. In addition to the deficiency of water resources, the distribution of water resources is uneven in Shaanxi Province, too, with more than three quarters of the total amount in the south, which covered less than one third of the whole area of the province. Furthermore, most of the rain of a year in Shaanxi Province falls during July to

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September, which also aggravates the dilemma of water resources.

2.2 Utilization of water resources in Shaanxi Province

2.2.1 Development and utilization of surface water

In 2010, the exploited and utilized quantity of surface water in Shaanxi Province was 4.952×10^9m^3, which accounts for 59.4% of the total amount of water utilization, including 1.843×10^9m^3 reserved, and 2.129×10^9m^3 drawn, 9.71×10^8m^3 pumped and 9×10^6m^3 artificially loaded.

2.2.2 Development and utilization of underground water

In 2011, the exploited and utilized quantity of surface water in Shaanxi Province was 3.334×10^9m^3, which accounts for 40% of the total amount of water utilization. Because of the over-exploration of underground water, six depression cones had been formed. They were the overdraft area in Xi'an City, the overdraft area in Xianyang City, the Peidong depression cone in Xianyang Qindu District, the Xinghua depression cone in Xianyang Xinghua City, the Luqiao depression cone in Xianyang Sanyuan County and the overdraft area in Weinan Duqiao.

2.2.3 Situation of urban water utilization

In 2010, the actual water consumption of all departments was 8.34×10^9m^3, including 4.96×10^9m^3 in agricultural irrigation, 7.82×10^8m^3 in forestry sector, fishery sector and animal husbandry sector, 1.206×10^9m^3 in industrial consumption, 1.072×10^9m^3 in the consumption of residents living, 3.19×10^8m^3 in the consumption in the domain of urban public and ecological environment, accounting for 59.5%, 9.4%, 14.5%, 12.8% and 3.8%, respectively.

In 2010, the total water consumption of Shaanxi Province was 4.876×10^9m^3, and the average water consumption rate was 58.5%. Among the consuming sectors, agriculture was the biggest and its water consumption quantity was 3.634×10^9m^3, while the industrial water consumption was 4.15×10^8m^3, the residents living consumption was 6.34×10^8m^3, the water consumption of urban public and ecological environment was 1.93×10^8m^3, accounting for 74.5%, 8.5%, 13% and 4%, respectively.

In 2010, the water consumption per capita of Shaanxi Province was 223.8m^3, and the water demand for every ten thousand CNY of gross domestic product (GDP) was 81.4m^3. Besides the demand of water resources for every ten thousand CNY of added value in above-scale industrial production was 15.7m^3, while the water consumption of agricultural irrigation per acre was 305.3m^3.

2.2.4 Water environment status

A large survey was released in 2010 that 90 river sections were monitored during the survey and the total length of the rivers involved was 4,886.7km. The survey findings show that, the rivers of pollution level 2–3, 4–5 and 5 accounted for 55.3%, 26.5% and 18.2%, respectively. The total waste water discharge of the year was 1.0748×10^{12}kg, of which the discharge of residents living made 4.235×10^{11}kg, the discharge of the second industry made 5.573×10^{11}kg, and the discharge of the third industry made 9.4×10^9kg, with 9.369×10^{11}kg flowing into the river.

3 The problems of water resources utilization in Shaanxi Province

3.1 Water resources were meager for the social and economic development growth

According to the information about the basic geographic situation yielded in 2012, Shaanxi Province can be divided into three regions: the Southern Shaanxi, the central Shaanxi plain and the Northern Shaanxi. The Northern Shaanxi, the biggest one of the three parts, accounted for 40% of the gross area (Wang, 2010), while the smallest part, the central Shaanxi plain accounted for 24% and the Southern Shaanxi accounted for 36%. And the annual GDP of the three parts in 2010 were 112.286 billion CNY, 630.543 billion CNY and 264.209 billion CNY, respectively. The water resources of the three parts were meager for the development of the society and economy with the amount of water resources of Southern Shaanxi totaling to 2.8006×10^{10}m^3, those of central Shaanxi plain and Northern Shaanxi to 7.633×10^9m^3 and 3.411×10^9m^3.

3.2 Water shortage and technological underdevelopment

The central Shaanxi plain is the pillar of economic growth of Shaanxi Province with a large population, making up to 62.69% of that of the whole province, but it is poor of water resources, with the total amount making only 19.4% of that of the whole province, and what's more, with the per capita amount far below the international warning line of water shortage, that is, 500m^3 per capita. Although the water demands of the residents were met by the water diversion projects, the current situation of water shortage had not been changed. The water technology is relatively backward in Shaanxi. Although the water reuse rate had reached 80%, except that over 90% in the coal-fired power plants, the rates were low in other industries, especially in the township enterprises. Moreover, as for the irrigation water, the conveyance loss was so massive that the average water efficiency in the canal system was less than 0.7, and the utilization factor was 0.53. Although the irrigation water quota fell in recent years by strengthening water saving measures, it was still at a lower level in our country.

4 Multi-objective programming model of the industrial structure under the limitation of water resources

4.1 The basic idea of the model establishment

For coordinated development of economy and environment, it is necessary to consider the coordinated development of water resources systems, social economic systems and environmental systems. Overall, the main objectives are: to maximize economic growth with limited water resources; to adjust the structure and distribution of the water supplies in the total area; to establish a reasonable value of each department of chemical oxygen demand (COD) emissions, to alleviate pressure on the water environment and to restore water ecosystems. Based on these three objectives, it is necessary to establish the multi-objective programming model of water resources, relating social advancement, economic development and environment with water supplying, water consumption and the value of COD emissions, so as to study the capacity of water resources at different levels, adjust the industrial structure, optimize water resources allocation, and promote economic, social and environmental development.

4.2 Multi-objective programming model

The solution of one problem needs to achieve multiple objectives, so a one-objective decision approach is more and more difficult to meet the needs of the people. As a branch of mathematical programming, multi-objective programming (MOP) mainly studies the optimization of multiple targets functioning in a certain area.

4.2.1 Set decision variables

Decision variable is a description of the actual state and development trends of the system model. For the optimization and adjustment of industrial structure, it reflects the proportion relationship among the first, the second, the third industry, so this relationship can be expressed by the industrial output value.

$\sum_{i=1}^{n} V_{1i}$ is the first industry output; $\sum_{i=1}^{n} V_{2i}$ is the second industry output; $\sum_{i=1}^{n} V_{3i}$ is the third industry output, in which, i is related industry output in each industry output.

4.2.2 Set the objective function

The optimization of the allocation of water resources means the maximization of the scale of economy, the minimization of the consumption of water resources and the minimization of the emissions of COD. The objective function is as $\mathrm{Max}\{f_1, -f_2, -f_3\}$.

The overall objective can be split into three sub-goals:

(1) Maximize GDP: Max $f_1 = \sum_{i=1}^{n} V_{1i} + \sum_{i=1}^{n} V_{2i} + \sum_{i=1}^{n} V_{3i}$.

(2) Minimize total water consumption: Min $f_2 = X_{\mathrm{ZYS}}$, X_{ZYS} is the total water consumption.

(3) Minimize the emissions of COD: Min $f_3 = X_{\mathrm{COD}}$, X_{COD} is the emissions of COD.

4.2.3 Set the constraints

Because in the real world, economic growth and water supplying are not unlimited, constraint variables need to be set. There are four main types of constraints: ① economic growth constraints, that is, there is a presence of growing upper and lower limits of economic growth based on certain historical conditions; ② total water supplying constraints, that is, the total amount of water resources is limited; ③ environmental capacity constraints, namely COD emission is not unlimited; ④ nonnegative constraints.

(1) Economic growth constraints. There are two kinds of economic growth constraints. The first is the total constraints, namely

$$V_{\mathrm{GDP}_{\min}} \leqslant \sum_{i=1}^{n} V_{1i} + \sum_{i=1}^{n} V_{2i} + \sum_{i=1}^{n} V_{3i} \leqslant V_{\mathrm{GDP}_{\max}} \tag{1}$$

where $V_{\mathrm{GDP}_{\min}}$ and $V_{\mathrm{GDP}_{\max}}$ are the lower and upper limits of GDP respectively.

The second is the industry output constraints, namely

$$V_{1_{\min}} \leqslant \sum_{i=1}^{n} V_{1i} \leqslant V_{1_{\max}} \tag{2}$$

where $V_{1_{\min}}$ and $V_{1_{\max}}$ are the lower and upper limits of the output of the first industry respectively, and the forms of the second and third industry, etc. are the same.

(2) The total water supply constraints.

$$X_{\mathrm{ZYS}} = W_1 \sum_{i=1}^{n} V_{1i} + W_2 \sum_{i=1}^{n} V_{2i} + W_3 \sum_{i=1}^{n} V_{3i} + W_{\mathrm{P}} P \tag{3}$$

$$X_{\mathrm{ZYS}} \leqslant X_{\mathrm{ZYL}} + X_{\mathrm{ZSS}},\ 0 \leqslant X_{\mathrm{ZSS}} \leqslant X_{\mathrm{ZSS}_{\max}} \tag{4}$$

where W_1, W_2 and W_3 are the water consumption per ten thousand CNY of the first, second and third industry output values, respectively; W_{P} is comprehensive capita water quota; P is the total population; X_{ZYL} is the total water resources of covering groundwater, surface water and other basin water transfer water; X_{ZSS} is regenerative water; $X_{\mathrm{ZSS}_{\max}}$ is maximum regenerative water.

(3) Environmental capacity constraints.

$$X_{COD} = \delta_1 \sum_{i=1}^{n} V_{1i} + \delta_2 \sum_{i=1}^{n} V_{2i} + \delta_3 \sum_{i=1}^{n} V_{3i} + \mu P \leqslant R_{COD} \quad (5)$$

where δ_1, δ_2 and δ_3 are the first, second and third industry COD generation coefficient; μ is the COD emissions per capita; R_{COD} is total capacity constraints of COD emissions.

(4) Nonnegative constraints. Three industrial output values cannot be negative, namely $\sum_{i=1}^{n} V_{1i} > 0$, $\sum_{i=1}^{n} V_{2i} > 0$ and $\sum_{i=1}^{n} V_{3i} > 0$.

4.2.4 Identify key parameters

In the model, the acquisition of many parameters data is mainly based on the water resources bulletin and the statistical yearbook. However, some data need to be combined with the actual situation in the region. They are shown as follows.

(1) The determination of $V_{GDP_{min}}$ and $V_{GDP_{max}}$. To determine the maximum and the minimum of GDP, it is necessary to determine the upper α_{max} and lower α_{min} rate of GDP growth according to the laws of economic development. Then according to the base year GDP forecast value, predict the maximum and minimum GDP of the planning year.

$$V_{GDP_{min}} = GDP_0(1 + \alpha_{min})^{(t_n - t_0)} \quad (6)$$

$$V_{GDP_{max}} = GDP_0(1 + \alpha_{max})^{(t_n - t_0)} \quad (7)$$

where GDP_0 is GDP values for the status quo year; t_0 is status quo; t_n is forecast.

(2) The determination of water W_i ($i = 1,2,3$) per ten thousand CNY output value.

For agriculture, the water = the quantity of water×irrigation water efficiency, therefore, the first industry $W_1 = W_{YS}/\eta$, W_{YS} is the first industry water use per ten thousand CNY output value; η is the water utilization coefficient of irrigation.

For the second and third industry, the water = the quantity of water + repeat water, so W_i ($i = 2,3$) just like water recycling rate linked to more comprehensive and accurate. The quantity of industry water per ten thousand CNY output value is available to the following formula:

$$W_i = W_{i0}(1 + \gamma_{i0})/(1 + \gamma_i) \quad (8)$$

where W_{i0} is the status quo per ten thousand yuan output value for the industry in the quantity of water; γ_{i0} is the recycling rate for the current situation in various industrial water; γ_i is the recycling rate for the planning of water in various industries; $i = 2,3$ denote the second and third industry, respectively.

(3) The determination of industry COD generation coefficient δ_i ($i = 1,2,3$) and R_{COD}.

$$\delta_i = C_i/V_i \quad (9)$$

where C_i is the total industrial COD discharge; V_i is industry output; $i = 2,3$ respectively denote the second and third industry. Because COD is mainly produced by the second and third industry, the general value of δ_1 is 0. R_{COD} can be obtained according to the relevant planning and environmental status.

4.3 The solution method of compromise constraint method

The essence of solving multi-objective programming is to transform it into a single objective function by processing each target, and then solve it with the method for solving a single objective function (Li, 2002). In the multi-objective programming method, it may be competition between multiple targets, that is, the improvement of a goal may damage another target. Thus, the multi-objective programming problems may not come from all the targets while achieving optimal solution, it is possible only under certain conditions, to achieve the optimum solution, but also for the efficient solution. Meanwhile, effective solutions may be more than one, relevant decision-makers need to select in the efficient solution (Wei, 2008). Therefore, in this selection of compromise constraint method to solve the multi-objective programming model as an example, the solution steps are shown as follows.

Step 1: solving linear programming problems Max f_1, the optimal solution $x^{(1)}$ and objective function value z_1^1.

Step 2: solving linear programming problems Max$\{-f_2\}$, the optimal solution $x^{(2)}$ and objective function value z_2^2.

Step 3: solving linear programming problems $Max\{-f_3\}$, the optimal solution $x^{(3)}$ and objective function value z_3^3.

Step 4: constructing super objective function $f = w_1 f_1 + w_2(-f_2) + w_3(-f_3)$, $w_1 + w_2 + w_3 = 1$, w_1, w_2 and w_3 are weights.

Step 5: constructing a compromise constraint $w_1[f_1 - z_1^1] + w_2[-f_2 - z_2^2] + w_3[-f_3 - z_3^3] = 0$.

Step 6: getting a compromise optimal solution to solve the Max f.

5 Multi-objective programming model of industrial structure optimization of Shaanxi Province

Taking Shaanxi Province as the research object, the authors selected 2010 as the current year for analysis, as this year was a critical of the Twelfth Five-Year Planning, and various development goals had been put forward; meanwhile, the authors selected 2020 as the future year for planning, according to *The development plan of Guanzhong-Tianshui economic zone*, *The Twelfth Five-Year Planning outline of economic and social development in Shaanxi Province*, *The urban system planning (2006–2020) of Shaanxi Province* and *The Twelfth Five-Year Planning outline of economic and social development of Xi'an*.

5.1 Construction of multi-objective programming model

5.1.1 The future development GDP goal of Shaanxi Province

Fluctuations may exist within a certain range in economic development, according to the *The Twelfth Five-Year Planning outline of economic and social development of Xi'an*, and combined with the current economic operation, α_{max} is identified as 15%, and α_{min} is identified as 8%. Thereby the upper and lower limit of GPD in each industry can be calculated, which are shown in Table 1. Meanwhile, according to the relevant planning, the GDP of Shaanxi Province in 2020 is more than double of that in 2010, and the average long-term annual growth reaches 12%, so the total economic development goal of Shaanxi Province in 2020 is 2.63339 trillion CNY.

5.1.2 The main variable and parameter estimation of multi-objective programming model

According to the relevant variables and the main parameters selected, the relevant data are identified. Detailed data are shown in Table 2.

Table 1

The GDP Extremum of Each Industry

The frist industry	The first industry GDP in 2020 (0.1 billion CNY)	The second industry	The second industry GDP in 2020 (0.1 billion CNY)	The third industry	The third industry GDP in 2020 (0.1 billion CNY)	Total	Total GDP in 2020 (0.1 billion CNY)
$V_{1_{min}}$	1,978.34	$V_{2_{min}}$	7,744.29	$V_{3_{min}}$	4,337.13	$V_{GDP_{min}}$	14,059.8
$V_{1_{max}}$	2,113.3	$V_{2_{max}}$	14,383.8	$V_{3_{max}}$	9,836.74	$V_{GDP_{max}}$	26,333.9

Table 2

Part of the Data of Shaanxi Province in 2010

Items	Unit	2010	Items	Unit	2010
Total population	Ten thousand people	3,735	Total GDP	0.1 billion CNY	10,123.48
The first industry output	0.1 billion CNY	988.45	The second industry output	0.1 billion CNY	5,446.10
The third industry output	0.1 billion CNY	3,688.93	Per capita water consumption quota (town/country)	m^3/(person·day)	0.163/0.041
The total water resources	$1 \times 10^8 m^3$	1,499.93	Renewable water (industry reuse included)	$1 \times 10^8 m^3$	3.76
The reuse rate of comprehensive water	%	28.31	Agricultural irrigation coefficient	%	53
The first industry water withdrawal	$1 \times 10^8 m^3$	57.42	Water consumption per ten thousand CNY of the first industry	m^3	580.91
The second industry water withdrawal	$1 \times 10^8 m^3$	12.06	Water consumption per ten thousand CNY of the second industry	m^3	22.14
The third industry water withdrawal	$1 \times 10^8 m^3$	3.19	Water consumption per ten thousand CNY of the third industry	m^3	8.65
Living water withdrawals (including municipal, environmental water)	$1 \times 10^8 m^3$	13.28	Total water consumption	$1 \times 10^8 m^3$	85.95
The total COD discharge amount of the second industry	t	119,269.6	COD discharge coefficient of the second industry	kg/ten thousand CNY	2.19
The total COD discharge amount of the third industry	t	53,858.38	COD discharge coefficient of the third industry	kg/ten thousand CNY	1.46
The COD discharge of domestic waste water	t	220,738.5	COD discharge per person	kg/person	5.91

Note: Data adapted from *The development plan of Guanzhong-Tianshui economic zone*, *The Twelfth Five-Year Planning outline of economic and social development in Shaanxi Province*, *The urban system planning (2006–2020) of Shaanxi Province*, *The Twelfth Five-Year Planning outline of economic and social development of Xi'an*, *2010 Shaanxi Provincial water resources bulletin* and *2011 Shaanxi Statistical Yearbook*.

According to the relevant plan, the constraints and the parameters of the computational part in the model are identified, which are shown in Table 3.

5.2 Calculation and analysis of multi-objective programming model

The authors try to solve it by programming calculation using Visual Basic 2008, according to the model and associated data parameters established above.

5.2.1 Solving with existing parameters unchanged

On the assumption of the restrictive condition parameters unchanged, and parameters are maintained under the current level, the procedure can be used to see whether it is possible to achieve the goal of GDP, the minimum water withdrawal and the minimum COD emissions through the adjustment of industrial structure, so as to optimize the allocation of water resources.

The results show that, at the current level, in case the situation and the coefficient of water utilization are maintained unchanged, under the condition of constant COD emission level, if the goal of GDP should be achieved in 2020, the proportion of three industries is 4.77:89.43:108.26. But this time the total water consumption is $1.6676\times10^{10}m^3$, among which the reclaimed water consumption is $5.003\times10^9m^3$, the total water withdrawal is $1.1674\times10^{10}m^3$. However, 71% of water resources in Shaanxi Province exists in the Southern Shaanxi; the GDP of Hanzhong, Ankang and Shangluo in the Southern Shaanxi in 2010 was respectively 48 billion CNY, 32.65 billion CNY and 26.6 billion CNY, which together accounted for only 10% of GDP in Shaanxi Province. At this level of development, only by adjusting the structure cannot solve the problems of water resources, economy and the unsustainable development of environment.

5.2.2 The compromise solution under limited conditions if parameter changes

According to the relevant constraints and development goals, suppose agriculture irrigation coefficient reaches 0.7, the recycling rate of industrial water reaches 90% and the rate of waste water reclamation and reuse reaches 30%.

By calculation, the results show that the model achieved a compromise solution, if the agricultural irrigation coefficient reaches 0.7, the recycling rate of industrial water reaches 90%, the reclamation and reuse rate of waste water will reach 40%. In 2020, the goal of GDP is 2.024696 trillion CNY, the output values of three industries are respectively 47.783 billion CNY, 894.312 billion CNY and 1.082601 trillion CNY, and then the proportion of three industries is 4.77:89.43:108.26. The total water consumption is $1.6676\times10^{10}m^3$, among which the first industry, the second industry, the third industry and people's living water consumption are respectively $4.688\times10^9m^3$, $5.36\times10^9m^3$, $5.267\times10^9m^3$ and $1.334\times10^9m^3$. The recycling rate of industrial water is 90%, and the amount of reuse water is $4.847\times10^9m^3$. The amount of renewable water is $2.64\times10^9m^3$, and the amount of new water withdrawal is $9.189\times10^9m^3$.

6 Conclusions and suggestion

All in all, Shaanxi Province should readjust the proportion of the three main industries in accordance with the requirements of the water saving society, in order to reduce the water consumption and pollution emission without slowing down the growth rate of economy. The specific gravity of the three main industries of Shaanxi Province was 0.9:5.9:3.6 in 2010, while the specific gravity of water consumption was 5.7:1.2:0.6. According to the result of the computation, these two indexes will change to 4.77:89.43:108.26 and 46.88:53.56:52.67,

Table 3

The Constraints and the Parameters of the Model

Items	Unit	2020
Total population	Ten thousand people	3,942.72
GDP	0.1 billion CNY	20,246.96
Water withdrawal of per ten thousand CNY	m^3	< 20
Agricultural irrigation coefficient	%	70
Sewage treatment rate	%	95
COD permissible discharge	t	76.98
The recycling rate of industrial water	%	> 80
The reuse rate of the reclaimed water	%	> 30

Note: Data adapted from *Statistical Yearbook of Shaanxi Province in 2011*, *The industry water quota of Shaanxi Province in 2010*, *2010 Shaanxi water resources bulletin* and *The Twelfth Five-Year Plan of environmental protection of Shaanxi Province.*

respectively. To achieve the goals of sustainable development of economy, rational utilization of water and improvement of water environment, these following aspects should be paid attention to.

(1) Further reducing of the proportion of the first industry and lowering of the total water consumption. It is necessary to improve the water-use efficiency of the agriculture irrigation water by developing modern water saving agriculture, changing the traditional mode of production and promoting the canal seepage control technology, the spray irrigation technology and micro-irrigation technology, because agriculture consumes a large amount of water in Shaanxi Province.

(2) Transforming of the traditional industry with modern water saving technology. It is necessary to reduce the waste of water resources during the productive process, and increase the amount of sewage recycling. Moreover, it is necessary to develop the cleaner production programs and contribute to the realization of the utilization of the sewage, by reconstructing water saving projects and controlling the water pollution. Meanwhile, it is important to adjust the industrial structure and reduce the scale of polluting industries.

(3) Controlling of living water consumption of the residents. To control the growth of the living water consumption, it is necessary to promote water saving instruments and the technology of reclaimed water, and direct the water demands by smart price leverage. In the domain of urban public water use, it is important to use more recycled water. And for the service sector, the utilization of the water saving instruments and reclaimed water is very important. Furthermore, decentralized waste water treatment and in-place recycling technology should be promoted in large communities, schools, enterprises and public institutions, to improve the efficiency of water using.

(4) Treatment of rainwater. Rainwater is an important part of available water resources, therefore, it is necessary to promote the rainwater utilization technology so as to increase the total amount of available water resources. Meanwhile, it is important to further increase the scale of the reclaimed water industry on the basis of the utilization of reclaimed water.

(5) Implementation of the water conservancy projects to change the water distribution of Shaanxi Province. It is essential to lessen the water resources shortage in the central Shaanxi plain and the Northern Shaanxi without influencing the normal economic growth of the Southern Shaanxi.

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