

Research on Optimal Allocation of Regional Annual Water Consumption

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Abstract: The optimization of regional water distribution refers to distributing regional and industrial water supply scientifically on the premises of limited regional water supply with an excess of demand for the purpose of fulfilling every industry's water supply. The study treats the optimal distribution of annual regional water consumption as a systematic dynamic optimization and analyzes its optimizing process, procedure and basic form of its models. The study constructs a regional water consumption system and raises a model to optimize regional water allocation that focuses on the water consumption standard of many categories, including living water, farm irrigation, forestry, animal husbandry, fishery livestock, industry, the public and environmental water demand of the city. Aiming at achieving the maximum comprehensive benefits of regional water consumption when dealing with its structure and habits, the optimal distribution model of regional water is devised after adopting the dynamic optimized distribution method to optimize the regional water consumption. As is shown by the research result, when applied to the regional water distribution optimization, this model can well optimize the distribution in every region and industry. It can thus coordinate among every system of water demand and supply in every region. This project study is significantly meaningful to ensure the scientific and reasonable water use in a region. It is also crucial to the sustainable utilization of water and sustainable development of society.

Keywords: Distribution, model, optimization, water consumption.

1. INTRODUCTION

Water resources are fundamental to people's survival and development. With the fast increase of world population and the rapid development of social economy, the gross water requirement soars greatly. It is necessary to seek a scientific method to distribute water, so that we can ensure the regional balanced operation between complex social economic water demand and supply [1, 2]. The aim of the research study is to find a solution that can optimize the allocation of water supply as well as to fulfill the water demand with the assigned gross water supply, therefore achieving maximum benefits [2, 3]. A lot of domestic and international experts and scholars have done researches and discussions in the field of optimal allocation of water [5-10]. With maximum production, delivery capacity and the prediction of demand as the constraints, D. Pearson used many reservoir control curves and the quadratic programming method to study on the issue of water distribution in the Nawwa area in Britain. Professor Hua Shiqian applied the system engineering approach to distributing water supply in the Beijing area. Feng Yaolong and others analyzed the principle of sustainable-development-oriented distribution of regional water supply and established a multi-aim model of water distribution for sustainable development. Weng Wenbin and others combined macroeconomics, system approach and the practice of regional water planning to compose the optimal water distribution theory based on macroeconomics. With

the guidance of this theory, he came up with the multistage, multi-aim and group-decision method and brought about the result of dynamic integration of water allocation and regional economic system, which was also a breakthrough among the researching approaches of optimal water distribution [11]. Based on the gross water supply level and constrained by the approved gross water supply, the annual regional water plan is devised in accordance with the society's requirement of reasonable and scientific water usage so as to keep the balance across all categories and industries [12]. When the annual water demand plan is in excess of limited water use or the available water supply, it should be reduced under certain rules and standards. The most common way of doing this is to reduce the water demand proportionate to its percentage in all the demands. This method is simple and easy to operate while it also has its disadvantage of lacking enough evidence and science. It may also fail due to ignorance of every industry's characteristics and benefits of water use. The case study raises a dynamic optimal distribution approach to optimize water distribution in all industries while the total water use is limited.

2. DYNAMIC OPTIMIZATION PROCESS AND MODEL

Optimal allocation of water resources is usually connected with optimal regulation of water amount and appropriate allocation, etc. Such problems are often generalized into multistep decision process. The so-called multistep decision process refers to the practice of separating research problems into various mutually related stages for which decisions are made correspondingly in order to optimize the entire process, whereas dynamic optimization is

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mainly applied to providing solutions to optimized questions, which may require for more than one solution, with each having its own mathematical value. Therefore dynamic optimization is to find out the most optimized (maximal or minimal) value [13, 14]. When a solution has several optimal values, usually only one is selected. Such decisions are made on the premise that no aftereffects should occur, i.e. solutions to later sub-problems would not be affected whatever choices are made. During the solution, such practice is determined to achieve optimal solution to the overall problem by solving the partial, sub-problems. The key to dynamic optimization is to save and provide the solution to repeating sub-problems during their first time of appearance, so that solutions won't be repeated when they appear for a second time or more [14, 15].

2.1. Dynamic Optimization Process:

As a matter of fact, dynamic optimization is a multistep decision process, which consists of stages, status, decisions and strategies [8, 16].

- (1) Stages: Represent the periods or procedures of the research target during its development. The stages are marked by stage variables, i.e. $i = 1, 2, \dots, N$, of which N represents the stage sum.
- (2) States: Refers to liable conditions at certain stage during the development of the system. Variables describing states of the system are known as state variables, usually represented by S . A stage state consists of both original state and end state, with the modal state of the former stage serving as the original state of the latter stage. If stage i has several S_{ij} ($j = 1, 2, \dots, m$) states numbered as m , its state set is marked as $S_i = \{s_{i1}, s_{i2}, \dots, s_{im}\}$.
- (3) Decisions: Refers to the decisions made during the transformation from one state to the next when the former stage state is settled. Decision is marked by decision variables, for example, $d_i(s_i)$ is used to represent the decision made during stage i of state s_i . There might be several viable decisions under one single state, yet decision variables are limited to one certain range, marked as $d_i(s_i) \in D_i(s_i)$, of which $D_i(s_i)$ is referred to as the allowed decision set of state s_i .

At one certain stage of multistep decision process, when system state s_i is set and decision d_i is made accordingly, the systematic state then transfers to the next state s_{i+1} . Transfer of systematic state is represented by the state transfer equation:

$$S_{i+1} = T_i(s_i, d_i), i = 1, 2, \dots, N \quad (1)$$

Where, T_i is the transfer function of the state.

State transfer equation shows that state S_{i+1} of stage $i+1$ is determined by state s_i and decision d_i , and is irrelevant to states before stage i .

- (4) Strategies: Represent a decision sequence. Strategies utilized the most during multistep decision process are the strategies of overall procedure and sub-procedure. Overall procedure refers to the process from the original state to the end state of stage 1, whereas sub-procedure k refers to the process from the original state to the end state of stage k .

The strategies of overall procedure and sub-procedure k are:

$$P_{1,N} = \{d_1(s_1), d_2(s_2), \dots, d_N(s_N)\} \quad (2)$$

$$P_{k,N} = \{d_k(s_k), \dots, d_N(s_N)\} \quad (3)$$

- (5) Stage Indicator Function: Serves as the evaluation indicator for profits gained through the transfer from decision d_i at original state s_i to s_{i+1} . Stage indicator function is the function of state and decision, which is represented as:

$$r_i = r_i(s_i, d_i) \quad (4)$$

Corresponding stage indicator functions of the overall procedure and sub-procedure are $R_{1,N}$ and $R_{k,N}$, which are the functions of the original state and the strategy:

$$R_{1,N} = \sum_{i=1}^N r_i(s_i, d_i) = R(s_1, P_{1,N}) \quad (5)$$

$$R_{k,N} = \sum_{i=k}^N r_i(s_i, d_i) = R(s_{k1}, P_{k,N}) \quad (6)$$

- (6) Target Function of Multistep Decision Process: Marks the optimal value of the indicator function of the overall procedure, i.e. the functional value of the overall procedure under optimal strategy:

$$R^* = \text{opt}R(s_1, P_{1,N}) = R(s_1, P^*) \quad (7)$$

- (7) Multistep Decision Process: Process from systematic original state s_1 to end state s_{N+1} after a series of state transformation, which is divided into N stages: decision d_i made during state s_i at state i renders effective after the systematic transfer to s_{i+1} . Multistep decision process is to make decisions stage by stage during the entire process to gain the optimal strategy and arrive at the optimal value R^* of the system indicator function $R_{1,N}$.

2.2. Basic Steps of Dynamic Optimization:

Designing an algorithm of standard dynamic optimization usually follows such steps:

- (1) Divide stages: Problems should be divided into several stages based on their temporal or spatial qualities. It should be noted that such stages should be sequential or subject to orderly arrangement (i.e. without backward tendency), otherwise the problems cannot be solved through dynamic designing.

- (2) Select states: Objective conditions at which problems are supposed to arrive during various stages should be marked as different states. Of course, the selection of the states should leave no aftereffects.
- (3) Determine the strategy and come up with the state transfer function: Since decisions and state transfers are naturally correlated, state transfer is supposed to reduce the state of the current stage based on the states and decisions of the last stage. The state transfer function hence would come out naturally once the decisions are made. However in practice, counter decisions are made based on the relationship among states of neighboring stages.
- (4) Write out the optimization function (including boundary conditions): Basic functions of dynamic optimization are the general expressive form of optimization functions.

2.3. General Forms of Dynamic Optimization Models:

Dynamic optimization model consists of three parts: target function, the constraint conditions and systematic functions to be met by stage states and decisions, and the systematic function, which is marked as:

Target function:

$$optR = \sum_{i=1}^N r_i(s_i, d_i) \tag{8}$$

The constraint conditions:

$$s_i \in S_i, d_i \in D_i(s_i), i = 1, 2, \dots, N \tag{9}$$

The systematic function:

$$s_{i+1} \in T_i(s_i, d_i), i = 1, 2, \dots, N \tag{10}$$

3. OPTIMAL REGIONAL ANNUAL WATER ALLOCATION MODEL

3.1. Dynamic Optimization Process:

Establish an optimal allocation model of annual regional water to distribute regional available water supply into civic living, farm irrigation, forestry, animal husbandry, livestock, fishery, industry, urban public, and ecologically environmental usages [17-19]. Water quota under each project will then be assigned to various sub-sectors. The optimal structure and system of annual regional water allocation is shown below in Fig. (1).

3.2. Structure and System of Optimal Annual Regional Water Allocation:

- (1) Stage Variables: Regional water is divided into six categories, including domestic usage, farm irrigation, forestry, animal husbandry, livestock, fishery, industry, urban public usage and ecologically environmental usages, with each one liable to be taken as a stage, therefore the stage variables are marked as $k = 1, 2, \dots, 6$;
- (2) Decision Variables: Annual water consumption of category k is represented as W'_k ;
- (3) State Variables: The amount of water available for allocation to current and future stages of water users, represented as q'_k ;
- (4) State Transfer Function: Based on the relationship between decision variables and state variables, the state transfer function is represented as $q'_{k+1} = q'_k - W'_k$;
- (5) Indicator Function: Indicator function of stage k is referred to as the usage benefit of water category k ;

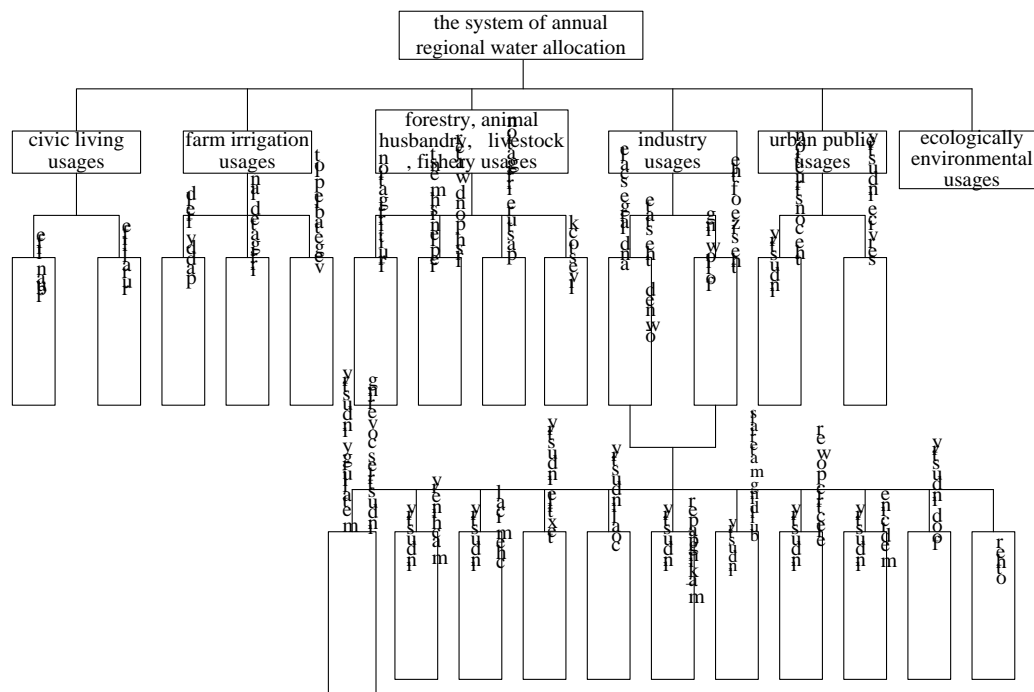


Fig. (1). Regional Annual water allocation optimization architecture.

(6) Target Function: Aimed at the maximum sum of all net benefit gained from water consumption of all categories, and the minimum sum of the corresponding variance of simulated and actual water consumption to distribute the total amount of water into regional living, farm irrigation, forestry, animal husbandry, livestock, fishery, industry, urban public and ecologically environmental usages, corresponding target functions are:

$$B(W') = \max \sum_{k=1}^6 B_k(W'_k) \tag{11}$$

$$T = \min \sum_{k=1}^6 (W_k - W'_k)^2 \tag{12}$$

Where, $B(W')$ is maximum annual profit (hundred billion RMB) gained from regulated amount of water based on the regional annual plan; W'_k is regional annual stimulated water consumption under category k , measured in hundred million m^3 ; W_k is regional annual actual water consumption under category k , measured in hundred million m^3 ; $B_k(W'_k)$ is net benefits obtained in category water k , hundred million RMB, $k = 1, 2, \dots, 6$, refers to water usages in regional living, farm irrigation, forestry, animal husbandry, fishery, industry, urban public and ecologically environmental usages; T is minimum sum of the variance of simulated and actual water consumption.

(7) Constraints

Approved annual water consumption constraints:

$$W' = \sum_{k=1}^6 W'_k \tag{13}$$

Regional water balance:

Upper and lower bound:

$$W'_{k,\min} \leq W'_k(t) \leq W'_{k,\max} \tag{14}$$

Restriction to the available amount of water during certain periods:

$$W' \leq W'_t \tag{15}$$

Variable non-negative constraints:

$$W'_k(t) \geq 0 \tag{16}$$

Where, $W'_{k,\min}$ represents the planned amount of water basically meeting the minimum need of water under category k , ten thousand m^3 ; $W'_{k,\max}$ represents planned amount water meeting the maximum need of water under category k , ten thousand m^3 ; W'_t represents the available amount of water during period t , ten thousand m^3 .

Reversed order method can be used to solve the above model, the basic function is:

$$f_k^*(q'_k) = \max \begin{cases} g_k(W'_k) + f_{k+1}^*(q' - W'_k), k = 1, 2, \dots, 5 \\ g_k(W'_k), k = 6 \end{cases} \tag{17}$$

Initial conditions: Water available for distribution in the first phase is no more than the total amount of water.

3.3. Benefit Function:

(1) Industrial Water

Water using efficiency computation adopts net output allocation method. The equation is represented as the following:

$$B_2(W'_2) = \beta \cdot (Q / W) \tag{18}$$

Where, β represents the benefit-sharing factor for industrial water, according to the research findings by Water Economy, generally the preferable number is 11%; Q is the industrial distribution of water, m^3 ; W is the industrial water consumption of ten thousand RMB output value, marked as m^3 /ten thousand RMB.

(2) Domestic Water

Taking efficiency generated through per cubic meter of industrial water as a reference, domestic water allocation accounts for different proportions of water, take a different scaling factor, multiplied by the per cubic meter of industrial water efficiency, the total benefits is calculated. Throughout the period, benefits of no more than 80% of the required amount of water per cubic meter are $\eta_1 - 1$ times higher than benefits gained by industrial water (including above and under scaled industries) per cubic meter. Benefits of over 80% of the required amount (but less than the required amount of living water demand) per cubic meter are considered as equal to the efficiency of industrial water per cubic meter, efficiency for the amount above the required demand of living water is marked as zero per cubic meter.

$$B_1(W'_1) = \begin{cases} \eta_1 B_0 Q_s, 0 \leq Q_s \leq Q_{s,\max} \\ \eta_1 B_0 (80\% Q_{s,\max}) + B_0 (Q_{s,\max} - 80\% Q_{s,\max}), \\ 80\% Q_{s,\max} \leq Q_s \leq Q_{s,\max} \\ \eta_1 B_0 (80\% Q_{s,\max}) + B_0 (Q_{s,\max} - 80\% Q_{s,\max}), \\ Q_s \geq Q_{s,\max} \end{cases} \tag{19}$$

Where, Q_s is the actual allocation of living water; $Q_{s,\max}$ is demand for domestic water; B_0 is the benefits of industrial water per cubic meter. $B_0 = \beta / W$ (β, W refer to the sharing value of industrial water benefits coefficient and water consumption of the industrial output of ten thousand RMB); η_1 is the ratio of living water benefits and industrial water benefits per cubic meter, the coefficient is determined as above 1 before living water meets the designing need, η_1 is determined as 1.8 when water supply does not reach 80% of the demanded amount of domestic water.

(3) Urban Public Water

Within 80% of the annual water demand, water benefits is $\eta_2 - 1$ times higher than industrial benefits per cubic meter, benefits of the amount above the 80% line (but less than the demanded amount of urban public water) are considered as equal to benefits of the industrial water. Benefit for the amount above the required demand of living water is marked

as zero per cubic meter. The production function is listed as follows:

$$B_3(W_3') = \begin{cases} \eta_2 B_0 Q_h, & 0 \leq Q_h \leq Q_{h,max} \\ \eta_2 B_0 (80\% Q_{h,max}) + B_0 (Q_{h,max} - 80\% Q_{h,max}), & 80\% Q_{h,max} \leq Q_h \leq Q_{h,max} \\ \eta_2 B_0 (80\% Q_{h,max}) + B_0 (Q_{h,max} - 80\% Q_{h,max}), & Q_h \geq Q_{h,max} \end{cases} \quad (20)$$

where, Q_h is the actual allocated amount of urban public water; $Q_{h,max}$ is the demand of urban public water; η_2 is the ratio of the benefits of urban public water per cubic meter and the benefits of industrial water per cubic meter. Coefficient is determined as above 1 when the amount of urban public water does not meet designing requirements, and η_2 is determined as 1.5 when the amount of water supply does not meet the 80% quota of designed water demand of urban public water.

(4) Eco-environmental Water

Eco-environmental water is the basic water to maintain regional ecological water environment, with the source usually coming from river, natural precipitation, recycled water and urban regenerated water or recycled water [20, 21]. Tap water is not utilized except for special occasions despite its high social and ecological benefits, because its direct economic efficiency is quite low. Therefore, in the process of making the calculation model, water used for the eco-environmental end is not included in the model for calculation.

4. CASE STUDY

In 2011, the water demand of urban life, rural life, secondary industry, tertiary industry, agriculture and ecological environment in a city totaled 2,141,890,000 m³. Whereas analysis conducted on data of the regional inflow and available water, combined with the amount of water

supply from higher authorities, the designed annual amount of urban water supply was 2,002,740,000 m³. With the planned amount of regional water supply being less than the total amount of water demand, further inspection is needed to determine the exact amount of water needed by water in urban life, rural life, secondary industry and tertiary industry, agriculture and ecological environment, while optimal allocation is also required

4.1. Optimal Allocation of Water by Category:

In accordance with the dynamic optimal allocation model that has been mentioned above, the MATLAB software is utilized to calculate optimal allocation. Take the condition of water supply being 2,002,740,000m³ as a constraint and maximizing benefits as a goal by optimizing the allocation of water supply, Table 1 shows the optimal water supply allocation model of each county. From Table 1, we can see that the water supply of the towns in this area is reduced by 3,860,000 m³, with the reduction rate being 1.3%; water supply of villages in the countryside is reduced by 11,750,000 m³, with the reduction rate being about 10%. As for water supply for secondary industries, the amount is reduced by 36,630,000 m³, with the reduction rate being 6.5%. Tertiary industry’s water supply is decreased by 11,680,000 m³, with the reduction rate being 3.0%. Water supply for agriculture is decreased by 74,400,000 m³, with the reduction rate being 9.0%. Water supply for eco-environment is decreased by 10,830,000 m³, with the reduction rate being 4.0%.

4.2. Optimal Allocation of Water by Category:

According to statistics on urban water usage, this project is determined to study the water consumption of industries covering metallurgy industry, machinery industry, chemical industry, textile industry, building materials industry, medicine industry, coal industry, electric power industry, paper-making industry and food industry. These ten industries consume over 90% of the entire amount of urban

Table 1. The outcome of optimal allocation of regional water among counties 10,000 m³.

Partition	Urban Life		Rural Life		Secondary Industry		Tertiary Industry		Agriculture		Ecological Environment	
	Water Demand	Plan of Water Supply	Water Demand	Plan of Water Supply	Water Demand	Plan of Water Supply	Water Demand	Plan of Water Supply	Water Demand	Plan of Water Supply	Water Demand	Plan of Water Supply
1zone	1757	1722	1523	1371	10681	9933	74	72	3076	2799	74	70
2zone	1072	1051	1134	1021	4830	4492	216	210	2027	1845	107	102
3zone	1225	1201	1324	1192	5732	5331	312	303	11497	10462	36	34
4zone	896	878	1197	1077	3776	3512	255	247	10815	9842	26	25
5zone	329	322	127	114	1956	1819	57	55	682	621	10	10
6zone	1513	1483	1486	1337	6206	5772	267	259	2644	2406	86	82
7zone	21743	21526	2233	2010	15057	14304	3793	3717	13672	12305	25872	24837
8zone	1107	1096	1082	974	5344	4970	383	372	3699	3366	259	246
9zone	1067	1046	1646	1481	3048	2835	238	231	34552	31442	369	351
total	30709	30323	11752	10577	56630	52967	5595	5427	82664	75224	26839	25756

water usage. However, different conditions may apply to different cities, therefore further adjustment needs to be applied to the specific industrial structure and characteristics of a city. In this case, we only formulate optimal water allocation model based on water consumption of such ten industries.

Build an optimal allocation model of water supply for every county and every industry and allocate the water yield to different industries in accordance with the water supply plan.

(1) Water Consumption Structure of Industrial Sectors

Water consumption structure of industrial sectors is formulated as below:

$$W_{1,2}(t) = F_{1,2} \left\{ \begin{matrix} W_{1,2,1}(t), W_{1,2,2}(t), W_{1,2,3}(t), W_{1,2,4}(t), W_{1,2,5}(t), \\ W_{1,2,6}(t), W_{1,2,7}(t), W_{1,2,8}(t), W_{1,2,9}(t), W_{1,2,10}(t) \end{matrix} \right\}$$

$$W_{1,2,i,\min} \leq W_{1,2,i}(t) \leq W_{1,2,i,\max} \quad i = 1, 2, \dots, 10 \quad (21)$$

where, $W_{1,2,1}(t)$ is metallurgical industry planning water supply in certain period t , 10,000 m³; $W_{1,2,2}(t)$ is machinery industry planning water supply in certain period t , 10,000 m³; $W_{1,2,3}(t)$ is chemical industry planning water supply in certain period t , 10,000 m³; $W_{1,2,4}(t)$ is textile industry planning water supply in certain period t , 10,000 m³; $W_{1,2,5}(t)$ is building materials industry planning water supply in certain period t , 10,000 m³; $W_{1,2,6}(t)$ is medicine industry planning water supply in certain period t , 10,000 m³; $W_{1,2,7}(t)$ is electric power industry planning water supply in certain period t , 10,000 m³; $W_{1,2,8}(t)$ is paper-making industry planning water supply in certain period t , 10,000 m³; $W_{1,2,9}(t)$ is food industry planning water supply in certain period t , 10,000 m³; $W_{1,2,10}(t)$ is coal industry planning water supply in certain period t , 10,000 m³; $W_{1,2,i,\min}$ is meet the basic demand of water supply made to satisfy the scale of production for the secondary industries, 10,000 m³; $W_{1,2,i,\max}$ is meet the maximum demand of water supply plan made to satisfy the scale of production for the secondary industries in certain period t , 10,000 m³.

(2) Optimal Water Allocation for Each Urban Industry

1) Optimal allocation

Adopt the optimal allocation model to allocate water supply for different industries in the city. Assume the planned water supply yield is Q , and the water demand of different unit $V_j (j = 1, 2, \dots, n)$ is q_j , the total water demand is:

$$Q_0 = \sum_{j=1}^n q_j \quad (22)$$

The profit function of the allocated water yield V_j towards X_j is $f(x_j)$, then:

Target function:

$$Maxf(x_j) = f(x_1) + f(x_2) + \dots + f(x_n) \quad (23)$$

The constraint conditions:

$$x_1 + x_2 + \dots + x_n = Q;$$

$$q_{\min} \leq x_j \leq q_j (j = 1, 2, \dots, n) \quad (24)$$

Among them, $f(x_j) = x_j \times P_j (j = 1, 2, \dots, n)$, P_j represents the j industry million Yuan RMB output value of water.

2) Determination of the Parameter

Profit function adopts ten thousand RMB output value methods to calculate the result. Relevant water consumption data in ten thousand RMB output value methods are cited from the city statistical yearbook.

3) Industrial Water Allocation

One city's allocated water yield for industrial uses is 529,670,000 m³, which includes metallurgy industry (101,930,000 m³), machinery industry (56,630,000 m³), chemical industry (45,300,000 m³), textile industry (16,990,000 m³), building materials industry (67,960,000 m³), medicine industry (39,640,000 m³), coal industry (113,260,000 m³), electric power industry (22,650,000 m³), paper-making industry (67,960,000 m³) and food industry (33,980,000 m³). The total water yield demand in all industries is 566,300,000 m³. Each of the profit function is $f(x_j) = x_j \times P_j (j = 1, 2, \dots, n)$. Use the optimal allocation model mentioned above and put the relevant data into the model, we should arrive at:

$$\text{Target function: } Maxf(x_j) = f(x_1) + f(x_2) + \dots + f(x_n) \quad (25)$$

The constraint conditions:

$$x_1 + x_2 + \dots + x_n = 52967$$

$$9600 \leq x_1 \leq 10193; 5102 \leq x_2 \leq 5663$$

$$4050 \leq x_3 \leq 4530; 1430 \leq x_4 \leq 1699$$

$$5780 \leq x_5 \leq 6796; 3580 \leq x_6 \leq 3964$$

$$11050 \leq x_7 \leq 11326; 1980 \leq x_8 \leq 2265$$

$$6200 \leq x_9 \leq 6796; 3260 \leq x_{10} \leq 3398$$

Use the model to solve out the result (shown in Table 2). From Table 2 we can see, the allocated water yield for metallurgy industry, machinery industry, chemical industry, textile industry, building materials industry, medicine industry, coal industry, electric power industry, paper-making industry and food industry are 100,870,000 m³, 51,310,000 m³, 41,460,000 m³, 14,300,000 m³, 58,940,000 m³, 36,010,000 m³, 111,560,000 m³, 19,820,000 m³, 62,360,000 m³ and 33,040,000 m³. Since different industry has different industrial structure, the water demand of industrial production and allocated water yield also vary. The industrial zone's total water consumption is reduced by

Table 2. Result of allocated water yield for industries 10,000 m³.

Partition	Urban Life		Rural Life		Secondary Industry		Tertiary Industry		Agriculture		Ecological Environment	
	Water Demand	Plan of Water Supply	Water Demand	Plan of Water Supply	Water Demand	Plan of Water Supply	Water Demand	Plan of Water Supply	Water Demand	Plan of Water Supply	Water Demand	Plan of Water Supply
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total	30709	30323	11752	10577	56630	52967	5595	5427	82664	75224	26839	25756

36,630,000 m³, 6.47%. In terms of total consumption, metallurgy industry has the smallest reduction, only 1.04%. Textile industry has the largest reduction, 15.83%. Based on this optimal model to simulate water supply allocation for every industry, the basic idea of the water demand and water consumption is prevalent in industries. The simulation result hence is quite sound.

5. CONCLUSIONS

When regional annual water demand is larger than the available water supply or the limited amount by the government, every region and industry lacks concrete evidence to decrease its water yield. It would be easy to neglect the different trait and water usage efficiency of every industry. Studying an optimal allocation model of water can help solve this problem better. Given the controlled total water consumption and the concept, theory, and calculation steps of optimal allocation of annual regional water, we aim to optimize the total regional water usage efficiency. With the limitation of the total regional water yield, we build an optimal dynamic annual water allocation model among regions. Through this optimal allocation model we adjust a city's plan to water consumption in areas such as domestic water, water for agricultural irrigation, water for forestry, animal husbandry, public facilities, environment and different industries. The result shows that this model can allocate and reduce water consumption of every water user. It's suitable to apply this model to optimize allocation of annual regional water.

CONFLICT OF INTEREST

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