Research on the Scheme of Multi-objective Planning Water Resources Optimization System Based on Network Model

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Abstract. Water resource scheduling is a key way to efficiently allocate regional water resources and enhance water use efficiency. This study takes the optimal scheduling of water resources in a certain area as an example. Aims to enhance the ecological, social and economic benefits in the scheduling area, and establish SD-MOP water resources optimal dispatch model. The results show that compared with the traditional SD model, the SD-MOP model predicts that the dispatch result in 2025 is closer to the actual water demand of the city, and saves the cost of 2.053 million yuan, and the pollutant discharge is only 0.89t, which brings considerable economic and environmental benefits.

Keywords: SD-MOP Model; Water Resources; Ecological Benefits; Optimal Dispatch

1. Introduction

Human survival and social progress are inseparable from the supply of water resources. Water resources occupy a basic and strategic position in social development and the progress of the times. At present, due to the deterioration of the water environment and the contradiction between water supply and demand caused by the development of cities and towns in our country, social and economic development is restricted [1], so to solve the problem of the rational dispatch of regional river basin water resources must be put on the agenda as soon as possible, paying attention to the contradiction between water scarcity and social development [2]. From the perspective of solving the contradiction of lack of water resources, the construction of the basin water resources dispatch model is to plan the water source allocation plan [3], and select the best one as the final practical plan of water resources optimization dispatch, and give full play to the economic benefits of the basin water resources. Social benefits and ecological benefits.

Based on the characteristics of water resources dispatching, this paper proposes a water resource optimal dispatch method based on the SD-MOP model to realize the comprehensive application of dynamic and static dispatch, linear and nonlinear dispatch. The specific ideas are as follows: (1) A
county-level water resource dispatch platform. As an example, the water resources dispatching experiment was carried out, and a multi-objective planning model was constructed under the guidance of the system dynamics model to ensure the common development of social benefits, economic benefits, and environmental protection benefits; (2) A multi-objective model for calculating water resources benefits was constructed, and the model parameters are solved one by one. Through county-level water resources dispatch experiments, we finally learned the ability and effect of the SD-MOP model to solve practical problems. This model achieved a balance between water supply and demand, saved water supply on the basis of meeting water supply demand, and gave full play to water resources. The comprehensive benefits of scheduling.

2. Research Area Overview
In this study, a model was constructed to simulate the experimental environment of water resources optimal dispatch simulation, and the water resources dispatch platform in a certain area was used as the carrier to analyze the effect of water resources optimal dispatch. The study area belongs to a temperate continental climate. The average annual precipitation in the past three years is 458.9mm. The overall precipitation is insufficient, and there are problems of uneven temporal and spatial distribution. Most of the precipitation is concentrated in June, July, and August for the past three years. The monthly precipitation in these three months averaged more than 200mm; while the precipitation in January, February, and December was only maintained at more than 50mm, the precipitation was relatively low, so the demand for water resources allocation in these three months was relatively high. Large; April, May, September, and October are the key seasons for the growth of agricultural plants. The demand for water resources allocation is also large, and precipitation is insufficient.

The pillar industry of the regional economy is agriculture. There are three major agricultural industrial zones in the region. Due to the relatively insufficient level of industrial development, most of the water consumption is concentrated in the agricultural sector. Based on the problem of inadequate water resources in general, the realization of water resource scheduling with the greatest benefit is of great significance to alleviating the problem of water shortage in the region.

3. Optimization of SD Water Resources Dispatching Model Based on Multi-objective Programming
The multi-objective planning method (MOP) is widely used in multi-objective decision-making fields such as social development and economic benefit evaluation, such as solving the problem of social water resources allocation and scheduling, and fully realizing economic and environmental benefits under the premise of ensuring the reasonable distribution of regional water resources [4][5]. This paper builds a MOP model based on the multi-objective programming method (MOP) to achieve linear and non-dynamic problem research. In the process of solving the problem of optimal scheduling of water resources, decision variables, objective functions, and constraints are the main components of the MOP model mathematical model. MOP model The specific expression is as follows:

\[
\max F(x) = [f_1(x), f_2(x), \ldots, f_p(x)]
\]

\[
r_i(x) \leq \eta_i
\]

In the formula, the constraint condition and the objective function are respectively adopted \( r_i(x) \) and \( \max F(x) \) expressed.

The principle of the MOP model to realize the optimal dispatch of water resources is to formulate multiple different dispatch plans and select the optimal plan according to the operation results. Due to the static and linear characteristics of the MOP model itself, the ability to solve the dynamic and nonlinear problems of water resources scheduling is insufficient, which is just complementary to the SD model [6]. Since the SD model and the MOP model have their own drawbacks and advantages in solving problems, the combined result of the SD-MOP coupling model has achieved complementary...
integrated characteristics. The SD-MOP coupling model constructed in this paper uses the gray Verhulst model to estimate the parameters of the SD model, and achieves the optimization of the scheduling model effect. Summarizing the process of the SD-MOP coupling model for water resources optimal dispatching is shown in Figure 1. The key process analysis is as follows:

Step 1: Build SD model. Comprehensive analysis of the internal structure of the water resources system operation, operation interference factors and other information, draws the cause and effect of the system operation, and builds the SD simulation model.

Step 2: Determine the sensitivity factor of the SD model. When the system is in operation, formula (3) is used to calculate the most significant sensitive factor of the basin subsystem interference:

\[
S(t) = \left| \frac{\Delta Y(t)}{\Delta X(t)} \right|
\]  

Among them, change parameters and output variables are used X and Y expressed separately; sensitivity is described by S description. The above formula is used to judge the most sensitive factors that interfere with the development of the image as the basis and basis for the construction of the MOP model.

Step 3: MOP model construction. The sensitivity factor obtained above is the basis for constructing the MOP model, and the set of optimal solutions of the sensitivity factor is also obtained by obtaining the model solution.

Step 4: Simulation of water resources optimal dispatch plan. Based on the set of sensitive factors, the SD-MOP coupling model is used to design the optimal dispatching of water resources, and to simulate and simulate.

Step 5: Evaluation and decision-making of water resources optimal dispatch plan. The decision-making team generally includes experts and leaders. Based on the simulation scheduling results, the water resources optimization scheduling plan is modified [7] to ensure that the best planning results are obtained. At this time, the program modification should be within the tolerance range of the optimal value of the sensitive factor.
**Figure 1.** Design of water resources optimal dispatch process based on SD-MOP coupling model

### 4. Analysis on the Effect of County-level SD-MOP Water Resources Optimal Dispatch

#### 4.1. Historical Data Inspection

After solving the model parameters, the effectiveness of the model implementation needs to be tested. The method used is the historical data verification method, which is to compare the error between the SD-MOP model constructed in this paper and the historical data. The definition error of this study is less than 10% When the time model passes the test, the SD-MOP model can be put into use. In the historical data inspection process, 2013-2015 is used as the inspection year, and domestic water consumption, industrial water consumption, and agricultural water consumption are used as inspection data. The SD-MOP model historical inspection results are shown in Table 1.

| Years | Test data type | SD-MOP model simulation data | Historical data | Model error/% |
|-------|----------------|-----------------------------|----------------|---------------|
| 2013  | Domestic water consumption/10,000 m³ | 37.4 | 39 | 4.1 |
|       | Industrial water consumption/10,000 m³ | 8.5 | 9.2 | 7.6 |
|       | Agricultural water consumption/10,000 m³ | 134.6 | 132 | 2.0 |
|       | Domestic water consumption/10,000 m³ | 42.6 | 41.1 | 3.6 |
| 2014  | Industrial water consumption/10,000 m³ | 9.9 | 9.5 | 4.2 |
|       | Agricultural water consumption/10,000 m³ | 132.9 | 135 | 1.6 |
|       | Domestic water consumption/10,000 m³ | 42.6 | 43.2 | 1.4 |
| 2015  | Industrial water consumption/10,000 m³ | 9.3 | 9.4 | 1.1 |
|       | Agricultural water consumption/10,000 m³ | 138.9 | 141 | 1.5 |

The error between the comparison model prediction data and the historical data is less than 10%, so the SD-MOP water resources coupling dispatch model constructed in this paper has been validated and meets the water resources dispatch data prediction standards.

#### 4.2. Analysis and Comparison of Water Resources Optimal Dispatching Effect

Comparing and evaluating the experimental effects of water resources optimal dispatching, and introducing comparative SD models to carry out water resources dispatching experiments simultaneously. The 75% guarantee rate is used as the basis for the constraint of water supply and demand at the county level, and water demand, water supply, cost savings, and pollutant discharge are used as variables to evaluate the dispatch effect. The results of the two models for water resources dispatch implemented in 2025 are shown in Table 2. Shown:
Table 2. Two models of optimal water resources dispatch results

| Evaluation index                     | Paper model | SD-MOP model |
|--------------------------------------|-------------|--------------|
| Industrial water demand/(10,000 m³)  | 9.6         | 9.6          |
| Industrial water supply/(10,000 m³)  | 8.8         | 8.4          |
| Water shortage difference/(10,000 m³)| 0.8         | 1.2          |
| Agricultural water demand/(10,000 m³)| 152         | 152          |
| Agricultural water supply/(10,000 m³)| 140.6       | 114.5        |
| Water shortage difference/(10,000 m³)| 11.4        | 37.5         |
| Domestic water demand/(10,000 m³)    | 48          | 48           |
| Domestic water supply/(10,000 m³)    | 47.1        | 43.1         |
| Water shortage difference/(10,000 m³)| 0.9         | 4.9          |
| Cost saving/ten thousand yuan        | 205.3       | 104.1        |
| Pollutant discharge/t                | 0.891       | 2.054        |

From Table 3, it can be seen that the two models dispatch water resources in the region, showing different dispatch in terms of industrial water supply, agricultural water supply, domestic water supply, economic benefits (cost saving), and environmental protection benefits (pollutant discharge). In general, the effects of this model in optimizing the dispatch of water resources are better than the SD model. Combined with Table 2, we can see that the industrial water demand, agricultural water demand, and domestic water demand of the study area in 2025 will be fixed under the two models, which are 96,000 m³, 1.52 million m³, and 480,000 m³ respectively. The estimated industrial, agricultural and domestic water supply are 88,000 m³, 1,406,000 m³, and 471,000 m³ respectively. The SD model estimates that the water supply is 84,000 m³, 1.145 million m³, and 431,000 m³, respectively. In contrast, the model scheduling in this article The result is closer to actual demand.

Based on the water supply data, cost saving data, and pollutant discharge data predicted by the model in this paper, it can be seen that the model in this paper successfully completes water resources dispatching while achieving a win-win situation for economic and environmental benefits. Compared with the SD model, the results are more reasonable. Comparing experiments with the SD model confirmed the significance of adding multi-objective planning on the basis of the SD model. In short, the model in this paper has achieved ideal water resources dispatch results and can be used in actual water resources dispatch forecasting practices in river basins.

5. Conclusion
The research based on the SD-MOP model has achieved remarkable results in the optimization of water resources dispatching. Compared with the traditional SD model, it can reflect better ecological and economic benefits in the actual water resources dispatching experiment. At the same time, the water supply distribution of the dispatch results closer to the actual water demand value. It can be used as a prediction method for water resources dispatching in actual river basins, providing a reference for the optimal dispatching of similar water resources.

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