Hindawi
Journal of Sensors
Volume 2023, Article ID 9805252, 1 page
https://doi.org/10.1155/2023/9805252

Retraction

Retracted: Research and Application of Optimal Allocation Model of Water and Soil Resources from the Perspective of Ecological Economics

Journal of Sensors

Received 3 October 2023; Accepted 3 October 2023; Published 4 October 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] L. Dai and X. Wang, "Research and Application of Optimal Allocation Model of Water and Soil Resources from the Perspective of Ecological Economics," *Journal of Sensors*, vol. 2022, Article ID 4579694, 15 pages, 2022.

Hindawi
Journal of Sensors
Volume 2022, Article ID 4579694, 15 pages
https://doi.org/10.1155/2022/4579694

Research Article

Research and Application of Optimal Allocation Model of Water and Soil Resources from the Perspective of Ecological Economics

Liuyi Dai[1,2] and Xinran Wang[2,3]

[1]*Department of Economics, Pusan National University, Busan 46241, Rep. of, Republic of Korea*
[2]*Baotou Teachers' College, Inner Mongolia University of Science and Technology, Baotou, Inner Mongolia 014030, China*
[3]*Department of Business Administration, Jeonju University, Jeonju 55069, Rep. of, Republic of Korea*

Correspondence should be addressed to Xinran Wang; 66211@bttc.edu.cn

Received 6 August 2022; Revised 23 August 2022; Accepted 8 September 2022; Published 12 October 2022

Academic Editor: Yuan Li

In order to solve the problem of realizing the rational allocation of water and soil resources in the watershed on the premise of ecological protection under the background of climate change, this paper proposes an optimal allocation model of water and soil resources from the perspective of ecological economics. In this paper, the use area of various land resources is taken as the decision variable, and the total amount of water resources available is taken as the constraint condition, and the multiobjective models under different scenarios are established, respectively. MOGWO algorithm is used to calculate the Pareto solution set under each scenario, and finally AHP is used to select the optimal solution with different decision preferences from Pareto. The experimental results show that under the current situation, the water shortage of the basin is 7.61×10^8 m^3. In the current planning year (2020), 950.7 km^2 of cultivated land should be reduced to meet the water resources situation of the river basin, accounting for about 17.8% of the total cultivated land, which is also in line with the basic policy of "well killing and land shrinking" advocated by the river basin in recent years. In the medium-term planning year (2035), the cultivated land area can be maintained at about 4300. Due to the increase of available water resources, water-saving irrigation area and irrigation water utilization coefficient, the cultivated land area in the long-term planning year (2050) can be increased by about 200 km^2 on the basis of the medium-term planning year. *Conclusion*. The model finally obtains the optimal solution in line with different decision preferences under different scenarios.

1. Introduction

China is a country with a large population and agriculture. Increasing grain output and ensuring food security are the cornerstone of economic development, social harmony and stability, and national independence and prosperity. Since the reform and opening-up, great achievements have been made in agricultural development. Only 9% of the world's arable land and 8% of fresh water resources are used to feed 22% of the world's population. On the whole, the supply and demand balance of food production has been achieved, and there is more than a good year [1]. The necessity of long-term sustainable development of soil and water resources: water is an irreplaceable precious resource for human survival and the material basis for social and economic development. Economic development and human life are inseparable from water supply and security. Water conservancy contains the development and utilization of water resources, harm, water conservation, water protection, and many other contents, and is the national economy and social development of the primary infrastructure and basic industry. However, there are many problems in the utilization of water resources in China, which are mainly shown as follows: first, the per capita water resources are low, the spatial and temporal distribution is uneven, and the utilization is extensive. The total supply of water in our country at present cannot meet the needs of socioeconomic development. At the same time, most of the water resources in China are extensive, do not pay attention to water saving, and waste is serious. The current definition of soil and water conservation refers to the comprehensive science and technology of preventing and controlling soil and water loss, protecting, improving, and rationally utilizing soil and water resources in mountainous, hilly and sandstorm areas, and maintaining and improving land productivity, so as to give full play to the economic and social benefits of soil and water resources and establish a good ecological environment. The meaning of soil and water conservation: in recent years, soil and water conservation and other disciplines infiltrate and absorb each other, and its connotation is also constantly expanded and enriched. Besides the prevention and control of the loss of soil and water resources, soil and water conservation also give the use of soil and water resources, greening and beautifying the environment. Soil and water conservation is a construction project with the nature of comprehensive management. It takes water and soil conservation as the center and comprehensively adopts rational use of land, biological measures, engineering measures, and agricultural technical measures to achieve the goal of improving ecological environment and sustainable development of regional social economy. The content of soil and water conservation is not only the prevention and control of soil erosion but also the maintenance and improvement of land productivity and the establishment of a good ecological environment. It can provide a safe guarantee for the sustainable development of the national economy and promote social progress. Soil erosion and soil conservation: soil erosion and soil conservation are two relative concepts, although not in the international classic dictionary. But according to some international academic monographs, their meaning is also relatively clear: it refers to the damage and loss of land surface water and soil resources and land productivity caused by soil erosion (including water, wind, gravity, and human activities). Soil erosion is an internationally used academic term in soil science. The definition of soil erosion is roughly the same in the international representative academic monographs and institutions, that is, soil loss under the action of water, wind, and gravity. The comprehensive control of soil and water conservation has an immeasurable effect on the ecological environment. Comprehensive control of soil erosion and soil conservation can effectively improve the soil ecological environment of the control area, reduce the soil erosion modulus, increase the forest and grass coverage rate, improve the air quality, and effectively store the precipitation, intercepting the sediment into the river. At the same time, it plays a positive role in alleviating the drinking water difficulties of people and livestock in mountainous and hilly areas, reducing flood disasters and resisting drought, and can create good conditions for the management of agriculture, forestry, and animal husbandry in the region, so as to increase people's income and provide strong support for the people to get rich as soon as possible. However, from the perspective of agricultural resources, China is one of the countries with relatively poor per capita resources. Per capita cultivated land is less than half of the world average level, and per capita water resources are particularly scarce, only one quarter of the world average level. The shortage of water and soil resources will become a fundamental long-term constraint in the development of modern agriculture. Especially after the 1980s, the restriction of water and soil resources on agricultural development has gradually intensified, and the contradiction between people and water and soil resources has become increasingly prominent. In addition, due to the impact of global warming, the rainfall in the North continues to decrease, coupled with the low utilization efficiency of water resources, the utilization efficiency of irrigation water is only 0.85 kg/m^3, less than half that of developed countries, the area of farmland suffering from drought continues to expand, food production is seriously reduced, and the rain disaster in the South continues to increase, etc., many problems directly or indirectly threaten the national food security. No. 1 central document in 2015 pointed out that under the hard constraints of resources and environment such as shortage of agricultural resources, overexploitation and increased pollution, ensuring the effective supply and quality safety of agricultural products, and improving the ability of agricultural sustainable development are major challenges we must deal with [2]. For human beings, water resources are an important dependence for survival. With the development of society and the increase of population, water resources have been seriously lacking. When human beings overuse water resources, the water resources ecosystem is seriously damaged, and the ecological environment of the region can only be maintained through the construction of reservoirs. The construction of reservoirs will occupy land resources, change the original geological structure of the land, and reduce the anticorrosion ability of the land. Therefore, people will protect the land resources while protecting the water resources. From the perspective of sustainable development of the water ecological environment, follow the laws of natural development and social and economic laws, focus on protection, and put ecological environmental protection in the same important position as social and economic construction. To realize the long-term progress of the market economy through the sustainable development of water and soil resources, analyze the principles that should be followed in the optimal allocation of water and soil resources, as follows: (1) adhere to the principle of giving priority to ecological and environmental protection. Realize the development and utilization of water resources, ensure the sustainable development of the urban economy, optimize the layout of agricultural production, and make the industrial production planning meet the conditions for the development and utilization of water and soil resources. Newly constructed projects, both in scale and layout, should conform to the carrying capacity of water and soil resources and improve project economic benefits on the basis of environmental protection. (2) Adhere to the principle of overall planning and consideration. Take into account the residents' domestic water use, residential land, agricultural and industrial water use, etc., rationally use surface water, arrange and store precipitation, and achieve efficient use of water and soil resources. (3) Adhere to the principle of taking into account both open source and throttling. Make full use of surface water, rationally use reservoir water resources, scientifically exploit groundwater, promote the construction of a water-saving society, and improve the utilization rate of water resources through effective sewage treatment projects.

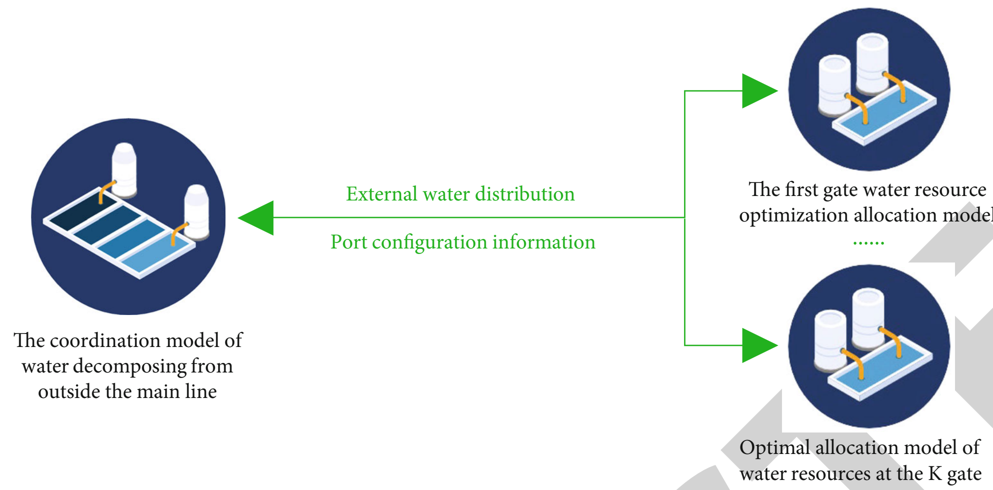

Figure 1: Optimal allocation model of water and soil resources.

Definition of indicators of ecoenvironmental impact assessment: ecoenvironmental impact assessment refers to artificial judgment of the significance, importance, and long-term consequences of the impact on the ecological environment. Its index: ecological evaluation index and benchmark; indicators and benchmarks for sustainable development assessment; policies and strategies as evaluation indicators and benchmarks; environmental protection and resource protection laws and regulations shall be used as evaluation benchmarks; take the economic value profit and loss and gain and loss as the evaluation index and benchmark; and social and cultural assessment benchmarks. At the national level, due to various constraints of the WTO, the quality and price of most agricultural products are facing extremely severe challenges. A large number of foreign grain imports continue to impact the production and sales of domestic grain; domestic grain production is in a critical transition period, and protective prices are no longer given to grain purchases. Grain prices are determined by market supply and demand, and the self-regulation ability of the market plays a decisive role in grain prices; at the regional level, since the beginning of the 21st century, China has been in a period of rapid changes in land use, with significant expansion of urban and rural construction land in the Huang-Huai-Hai Plain, the southeast coastal areas and the Sichuan Basin, rapid urbanization and industrialization, and the occupation of large-scale high-quality farmland, the trend of crowding out water and soil resources is difficult to reverse, and the area of paddy fields in the South has also been significantly reduced. Since the implementation of the policies of “western development” and “ecological conversion of farmland”, oasis agriculture in Northwest China has developed, but the effect is not significant enough; although the northeast region has carried out short-term reclamation and the dry land area has increased slightly, in the later stage, affected by the land development strategy, the Northeast Revitalization Strategy and other policies, the forest land area increases, while the cultivated land area decreases or is occupied, and the realization of the goal of high and stable grain yield will face more severe pressure. Figure 1 shows the optimal allocation model of water and soil resources.

Lamnatou and Chemisana proposed to divide ecosystem services into 17 kinds, including atmospheric regulation function, disturbance regulation function, climate regulation function, water regulation function, genetic resources function, and entertainment and cultural function. Daily and de Groot divided ecosystem services into regulation function, habitat providing function, production function, and information transmission function. At present, a more influential functional classification is to divide ecosystem service functions into supply services, regulation services, cultural services, and support services, which was proposed by the Millennium Ecosystem Assessment Team (abbreviated as MA) in 2003 [3]. Rehman et al. studied the classification of ecosystem service value according to the degree and duration of economic benefits, and the classification proposed is based on the above classification and is basically the same. At the same time, the United Nations Environment Programme (UNEP) from the perspective of biodiversity, the organization for economic cooperation and development (OECD) according to the nature of products through the market and consumption [4]. Li et al. studied the impact of water rights quality on water resources allocation efficiency, utilization efficiency, and economic efficiency [5]. There are also some new research methods applied to the study of water resources, such as artificial neural network, genetic algorithm, game theory, and fuzzy theory. The birth and application of these new methods make the optimal allocation of water resources more comprehensive, extensive, and diverse. Christensen and Bisinella preliminarily evaluated six service functions in China’s terrestrial ecosystem, including the production of organic matter, the maintenance of the balance of atmosphere, the circulation and storage of nutrients, water and soil conservation, the conservation of water sources, and the purification of environmental pollution by the ecosystem. By analyzing the relationship between the structure and process of ecosystem services, they evaluated the ecosystem service value of Hainan Island [6]. Dca et al. used relatively complete meteorological observation records in a city to analyze the spatial and temporal changes of temperature and precipitation. The results show that the climate change in Xinjiang is basically the same with the global and national climate change trend, but it has obvious regional characteristics: the warming pace is slowing down, and the humidification momentum is not reduced. The accompanying extreme climate events such as blizzard, rainstorm, cold temperature damage, and drought appear frequently, and the cold wave weather is significantly reduced, resulting in the temperature increase in winter is higher than in summer, which makes the air distribution of solar and thermal resources in Xinjiang change in time. In the past 50 years, especially in the past 10 years, the obvious change of climate temperature has a positive impact on the ecological and environmental changes in Xinjiang, which makes the agriculture and animal husbandry structure in Xinjiang change quietly and plays a role in promoting the development of national economy [7]. Dan et al. starting from the characteristics of mineral resources, combined with the example study, build by the sustainable goals and environmental goals, expert evaluation, matrix method, intensity analysis, and GIS technology of mineral resources planning environmental impact assessment system, and quantitatively evaluate the current situation of the mining environment and planning caused by environmental changes for our mineral resources planning environmental impact assessment [8]. Zaa et al. with the development of national economy and the acceleration of urbanization process, industrial and domestic water will increase sharply, while agricultural water can only have zero growth or even negative growth. Therefore, to improve the utilization rate of agricultural water resources, the development of efficient water agriculture is the only way for the development of modern agriculture in the future. On the one hand, China is in a shortage of water resources, but on the other hand, there are low efficiency and serious waste of agricultural water use. Therefore, the development of efficient water agriculture is not only necessary, but also feasible. Modern high-tech technology, especially information technology, also provides possible and new ways for the development of efficient water agriculture [9]. Under the background of climate prediction, this paper constructs four scenarios: short-term planning of low emission concentration (RCP4.5 2035), long-term planning of low emission concentration (RCP4.5 2050), short-term planning of high emission concentration (RCP8.5 2035), and long-term planning of high emission concentration (RCP8.5 2050). Taking the use area of various land resources as the decision variable and the total amount of water resources available as the constraint conditions, multiobjective models under different scenarios are established, respectively. MOGWO algorithm is used to calculate the Pareto solution set under each scenario. Finally, AHP is used to select the optimal solution with different decision preferences from Pareto, which provides a reference for the allocation of water and soil resources in a watershed in different scenarios.

2. Methods

2.1. Connotation of Ecological Economic Efficiency. ECO economic efficiency has different titles in different disciplines and research fields. It is usually called "ecological efficiency" or "environmental efficiency" in Environmental Science and ecology. Until 1992, the WBCSD published the book change course, which pointed out that in order to change the polluter into the promoter of global sustainable development, enterprises need to pay attention to the combination of environment and economic development in the production process, and meet the needs of improving the quality of human life by creating products and services with price competitive advantages. At the same time, the intensity of its environmental impact and resource utilization will be reduced to a level consistent with the earth's carrying capacity. So far, the concept of ECO economic efficiency has been formally put forward and widely accepted. In the subsequent theoretical research and practical operation, the organization for economic cooperation and development (OECD), the European Environment Agency (EEA), the United Nations Council for the promotion of trade (UNCTAD), and other organizations have made different summaries of its connotation. After combing the relevant literature, this paper summarizes the representative concept expression as shown in Table 1.

Summing up scholars' understanding of ecological economic efficiency, it is not difficult to see that ecological economic efficiency is actually a relative concept, which represents the relationship between the value of economic output products or services (i.e., the amount of services provided by artificial capital) and ecological consumption (natural capital consumption) such as resources and environment. For different purposes and available information, its application is also relatively flexible: it can be expressed as a strategic goal, but also as a method and index system to measure strategic progress. Based on the above connotation, through the quantitative evaluation of input-output indicators, the conceptual model of ECO economic efficiency can be expressed as

$$\begin{aligned}&\text{ECO economic efficiency}\\&=\text{amount of services provided by artificial capital/amount of natural capital sacrificed}\\&=\text{value of products and services/consumption of natural capital}\end{aligned} \tag{1}$$

Production capacity, output value, and sales volume can be used to express the value of products or services, while the impact of enterprises, industries, or an economy on the environment can be expressed by indicators such as total energy consumption, total raw materials, and waste emissions. From the above expression, it can be seen that compared with the simple pursuit of economic efficiency, ecological economic efficiency emphasizes the coordinated development of ecological economy, that is, to create economic value while taking into account the stability of the ecosystem, which requires that the impact of human economic activities on the ecosystem must be limited within the scope of ecological carrying capacity [10]. Specific to the production activities of micro enterprises, enterprises are required to have the ability to innovate, enhance competitiveness, and constantly improve the relationship between economy and environment, so that enterprises can improve their own economic benefits while avoiding damage to the ecological environment [11].

Table 1: Summary of ECO economic efficiency.

Organization name	Connotation
World chamber of commerce and industry for sustainable development (WBCSD)	While providing products or services that meet the needs, the intensity of resource, and energy use and environmental impact of enterprise production should be minimized.
Organization for economic development cooperation (OECD)	The efficiency of natural resources to meet the needs of human society.
European environment agency (EEA)	Create more welfare with the least natural investment.
United nations association for the promotion of trade (UNCTAD)	The impact of the unit economic value of enterprise output on the environment.
BASF corporation	In the whole life cycle of products, resources should be protected by saving energy and materials as much as possible and reducing pollutant emissions.
International financial organization environmental investment department (EFG-IFC)	Improve the sustainability of resources through more efficient production methods.
Australian department of environment and heritage (AGDEH)	Provide more products and services with less energy and resources.
Industry Canada	Achieve the maximum benefit output with the least input of raw materials.
International finance corporation (IFC)	Improve the sustainable utilization of resources through various methods.

2.2. Establishment of Multiobjective Model

2.2.1. Decision Variables. Decision variables refer to the variables that need to be solved in the model, which are usually used to indicate the quantitative schemes and measures in planning. Decision variables can be determined and controlled by decision makers. In the optimal allocation of water and soil resources, the decision variables need to reflect the change results of various objective function values at the same time and realize the constraints expressed by each constraint variable. This paper takes the area of different land use types in each administrative region in the basin as the decision variable. The land use types include cultivated land, grassland, forest land, construction land, water area, and unused land.

2.2.2. Objective Function. In recent years, the ecological crisis of the river basin has become increasingly urgent, so this paper adds ecological goals on the basis of considering the economic and social goals of the river basin. It is expressed by the maximum gross national product (GDP), the maximum benefit of water use per cubic meter, and the maximum ecological green equivalent.

(1) Economic benefit objective

Economic benefits can be directly expressed through the regional gross national product. In this paper, according to the maximum GDP generated by different types of land use structures, the economic benefit goal is as follows:

$$F_1(x) = \max \sum_{i=1}^{n} a_i x_i. \tag{2}$$

Where x_i is the area of various types of land (km^2); a_i is the gross national product per unit area of various types of land (104 yuan/km^2).

(2) Social benefit objective

Due to the influence of many factors, the quantification process of social benefits is relatively complex, so its representative indicators are usually selected to reflect the social benefit goals in practical problems. Considering the effectiveness of optimal allocation of water and soil resources, this paper selects the maximum benefit of single cubic meter of water as the social benefit goal.

$$F_2(x) = \max \frac{\sum_{i=1}^{n} a_i x_i}{\sum_{i=1}^{n} d_i x_i}. \tag{3}$$

Where x_{i} is the area of various types of land (km^2); d_i is the water demand per unit area of different land use types (10^4 m^3/km^2).

(3) Ecological benefit target

There are many ways to quantify the ecoenvironmental benefits of river basins: (a) quantify the water supply assurance rate of ecoenvironmental users; (b) quantify the content of COD in the user's drainage; (c) minimize the total amount of groundwater supply; (d) quantification by green equivalent value; (e) the satisfaction degree of ecological water demand in irrigation area is maximized; and (f) quantify the value of ecosystem services. This paper aims at finding the direct relationship between different water and soil resource allocations and ecoenvironmental benefits. Considering the actual situation of the study basin, the green equivalent value of different land use types is selected to quantify the ecoenvironmental benefits.

Ecological green equivalent is proposed based on measuring the ability of ecological compensation. Ecological compensation refers to the buffer and compensation effect of natural ecosystem on the destruction of ecological environment caused by social and economic activities. The size of ecological green equivalent is usually measured according to the service value of each land use type to the ecosystem. The forest, known as the "lungs of the earth", has important regulatory functions for the atmosphere, water, soil, space, and biology. When measuring the green equivalent of different land types, the ecological service function of the forest is often used as the benchmark to evaluate the ecological service value of other land use types [12]. Considering the quantification of different ecological service values, this paper sets the forest ecological green equivalent value as 1 and the ecological green equivalent value of construction land as 0 and then calculates the green equivalent value of other land types through the scores of different land use types and forest ecological service values.

Taking the maximum total ecological green equivalent of the basin as the ecological benefit goal of the basin is as follows:

$$F_3(x) = \max \sum_{i=1}^{n} c_i x_i. \tag{4}$$

Where x_i is the area of various types of land (km^2); c_i is the green equivalent value of each type of land per unit area.

2.2.3. Constraints

(1) *Water Resource Constraints*. The total water demand of different land use types in the study area does not exceed the available supply of water resources in the basin.

$$\sum_{i=1}^{n} d_i x_i \leq W. \tag{5}$$

Where x_i is the area of various types of land after planning (km^2); W is the available supply of water resources in the basin; and d_i is the water demand per unit area of different land use types.

(2) *Total Land Area Constraint*. The sum of all land types in the study area does not exceed the total amount of land resources.

$$\sum_{i=1}^{n} x_i \leq T. \tag{6}$$

Where x_i is the land area of each land type after planning (km^2); T is the total drainage area.

(3) *Cultivated Land Constraints*. Land use planning should ensure that it does not cross the "cultivated land red line". According to the current cultivated land in a river basin and the basic policy of "well killing and land shrinking" in the basin, this paper sets the cultivated land red lines under four scenarios in the basin.

$$X_1 \geq \mathrm{CL}_{\mathrm{min}}. \tag{7}$$

Where X_1 is the cultivated land area after planning (km^2); $\mathrm{CL}_{\mathrm{min}}$ is the "cultivated land red line" of the study basin.

(4) *Constraints on Construction Land*. With the growth of the economy and population of the basin, the area of construction land in each administrative region of the basin is bound to increase.

$$X_2 \geq \mathrm{BL}_{\mathrm{now}}. \tag{8}$$

Where X_2 is the area of construction land after planning (km^2); $\mathrm{BL}_{\mathrm{now}}$ is the current construction land area of the study area.

(5) *Forest Area Constraint*. Considering the urgency of ecological protection in the basin in recent years, the forest area should not be less than the current forest area.

$$X_3 \geq \mathrm{FL}_{\mathrm{now}}. \tag{9}$$

Where X_3 is the forest area after planning (km^2); $\mathrm{FL}_{\mathrm{now}}$ is the current forest area in the study area.

(6) *Water Area Constraint*. Considering the importance of water area to maintain ecological stability and irrigation agriculture, the current water area is the lower limit.

$$X_4 \geq \mathrm{WL}_{\mathrm{nfy}}. \tag{10}$$

Where X_4 is the water area after planning (km^2); $\mathrm{WL}_{\mathrm{nfy}}$ is the current water area of the study area.

(7) *Constraints of Unused Land*. Unused land mainly includes sandy land, saline alkali land, and other land with poor geological conditions, and its improvement and use are generally difficult to achieve in the short term, so it is assumed that its area remains unchanged.

$$X_5 = \mathrm{NL}_{\mathrm{now}} \tag{11}$$

Where X_5 is the area of unused land after planning (km^2); $\mathrm{NL}_{\mathrm{now}}$ is the current unused land area of the study area.

(8) *Nonnegative Constraint*. All variables should be positive to ensure their effectiveness.

2.3. Solution and Solution Set Optimization of Multiobjective Model

2.3.1. Gray Wolf Optimization (GWO) Algorithm. The main inspiration of gray wolf optimizer comes from the hunting

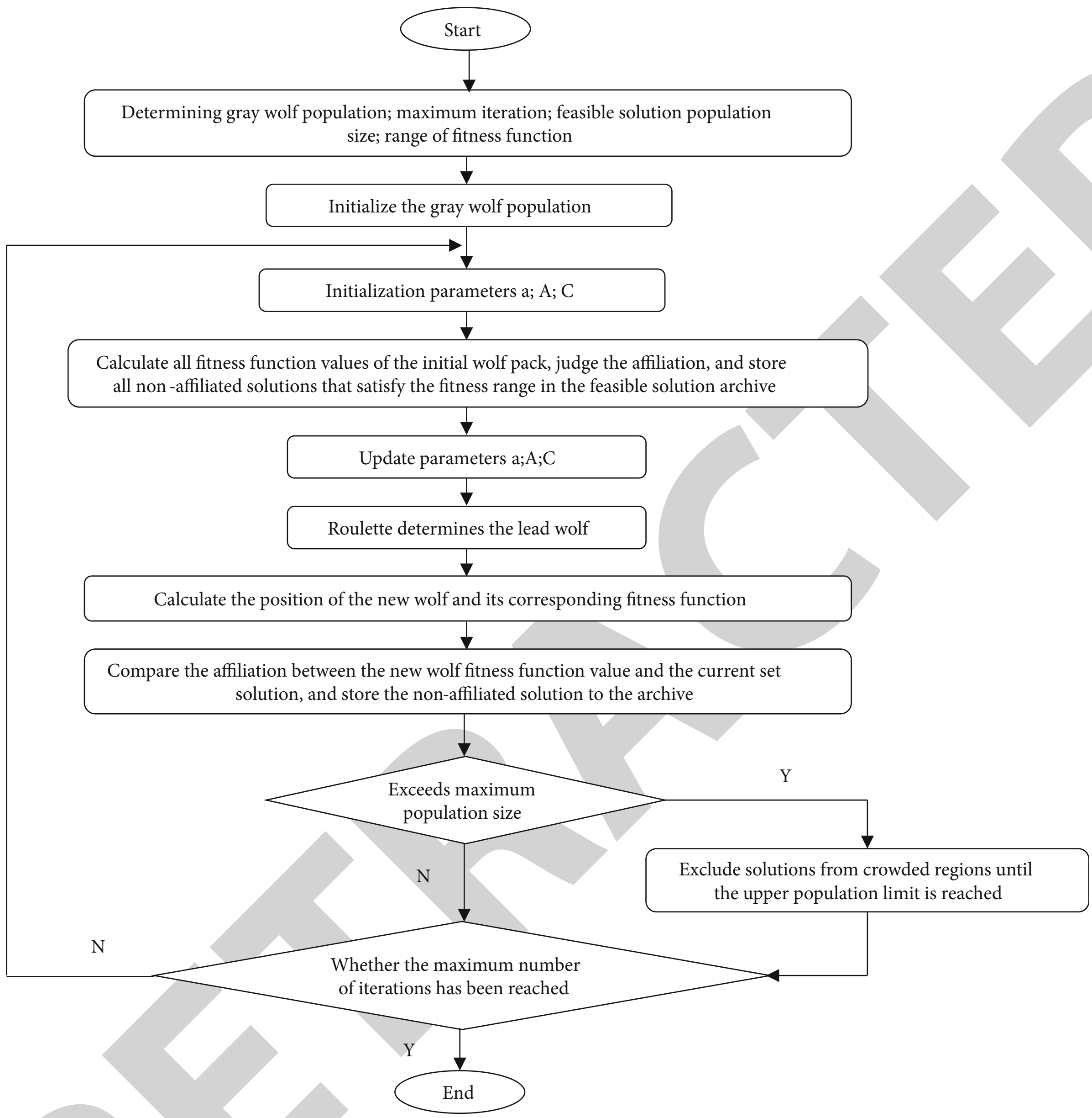

Figure 2: Gray wolf algorithm structure.

Table 2: Establishment of decision variables.

Administrative region	Cultivated land	Grassland	Woodland	Construction land	Waters	Unused land
County A	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}
County B	x_{21}	x_{22}	x_{23}	x_{24}	x_{25}	x_{26}
County C	x_{31}	x_{32}	x_{33}	x_{34}	x_{35}	x_{36}
County D	x_{41}	x_{42}	x_{43}	x_{44}	x_{45}	x_{46}
City E	x_{51}	x_{52}	x_{53}	x_{54}	x_{55}	x_{56}
City F	x_{61}	x_{62}	x_{63}	x_{64}	x_{65}	x_{66}

technology of gregarious gray wolves. The gray wolf population has a strict hierarchy, in which α is called "head wolf", which is the leader of the whole gray wolf population and is responsible for decision-making. β is the gray wolf subordinate to α, assisting α in decision-making, δ is responsible for detection and warning and predicts the location of the

Table 3: GDP per unit area of different land use types (10^2).

Administrative region	Cultivated land	Grassland	Woodland	Construction land	Waters
County A	317.2	5.3	6.1	2597.5	11.4
County B	397.3	11.4	22.9	3329.1	150.1
County C	474.3	6.6	0.7	3737.7	0
County D	298.9	10.6	0.9	1587.9	0.2
City E	402.4	49	20.3	5558.6	34
City F	645	497.1	34	1696.9	40.4

Table 4: Scoring table of ecological service functions of different land types.

	Ecological function	Cultivated land	Grassland	Woodland	Construction land
Atmosphere	Atmospheric composition improvement-1	7.12	7.24	9.65	4.45
	Atmospheric composition improvement-2	5.21	5.44	9.92	5.11
	Air purification-1	6.53	6.72	9.54	6.45
	Air purification-2	6.66	6.82	8.66	6.12
	Mild climate	6.23	6.33	9.65	9.12
	Antinoise	4.12	4.21	9.55	4.35
Water	Flood prevention	6.88	6.92	9.88	9.88
	Water conservation	7.24	7.64	9.68	10
	Water purification	7.25	7.56	9.21	9.87
Soil	Prevent the collapse of soil and sand	7.85	8.01	9.87	8.65
	Prevent surface erosion	8.24	8.54	9.67	6.87
	Prevent the ground from sinking	7.86	7.99	6.12	8.11
	Pollutant purification	8.44	8.55	9.12	8.87
	Prevent disasters	7.45	7.66	9.42	8.02
Space	Provide refuge	6.88	7.02	8.44	3.02
	Maintain the landscape	7.98	8.33	9.25	9.92
	Maintain entertainment space	3.88	8.42	8.64	7.66
Biology	Biodiversity conservation	5.67	7.31	9.99	8.56
	Prevent harmful animals and plants	6.21	7.03	5.98	6.77

Table 5: Ecological green equivalent per unit area of different land types.

Land use type	Cultivated land	Grassland	Woodland	Construction land	Waters	Cultivated land
Ecological green equivalent per unit area	0.34	0.37	1	0.82	0	0

Table 6: MOGWO parameters.

	Gray wolf number	Feasible solution	Range of change	Iterations
Quantity	100	100	20%	1000

optimal solution together with α and β, and ω is the candidate wolf, responsible for supplementary encirclement and attack [13]. Gray wolf algorithm is widely used in solving single objective and multiobjective constrained programming models in recent years because of its stable performance and fast convergence speed.

2.3.2. Multiobjective Gray Wolf Optimization (MOGWO) Algorithm. Gray wolf algorithm is too affected by the initial value and easy to fall into local optimization when solving multiobjective problems. Therefore, MOGWO adds two new components on the basis of GWO:

(1) An external population archive is introduced to store the current nondominated Pareto optimal solution. At the end of each iteration, compare the relationship between the current solution and the archive solution set: if there are solutions in the archive solution set that dominate the current solution, skip the current solution; if the existing solution in the archive solution set is dominated by the current

Table 7: Comparison of importance of AHP parameters.

Importance	Generally important	Relatively important	Important	Very important	Extremely important
Value	1	3	5	7	9

Table 8: AHP calculation results.

Year	Weight			Inspection index	
	Economic goal	Social goal	Ecological goal	CI	CR
2020	0.6267	0.0936	0.2797	0.0429	0.0825
2035	0.5695	0.0974	0.3331	0.0123	0.0236
2050	0.5273	0.0992	0.3735	0.0018	0.0036

solution, replace all the dominated solutions with the current solution; if all solutions in the archive solution set have no interactive relationship with the current solution, the current solution will be added to the solution set; when the number of solutions in the archive solution set reaches the set number, find the area with high congestion, round off one of them, and insert a new solution in the area with low congestion.

(2) Add a new "coyote" selection mechanism. In GWO, for single objective problems, the coyote can be the individual with the largest target value in α, β, and δ. However, MOGWO generally has two or more target values, and the absolute optimal solution cannot be selected. Since GWO could not choose the best coyote when solving multiobjective problems, use roulette to select the leader of the next iteration in archive. At the same time, in order to improve the global search ability of the algorithm, the probability of each individual being selected in the archive is inversely proportional to their congestion, as shown in

$$p_i = \frac{C}{N_i}. \quad (12)$$

Where C is a constant greater than 1 and N_i is the number of individuals in the group where the i-th individual is located.

Combining GWO with newly added components, the basic process of MOGWO is shown in Figure 2.

2.3.3. Analytic Hierarchy Process (AHP). Analytic hierarchy process (AHP) is a multiobjective decision analysis method that combines qualitative and quantitative analysis methods. The main idea of this method is to decompose the complex problem into several levels and several factors, compare the importance of two indicators, establish a judgment matrix, and obtain the weight of the importance of different schemes by calculating the maximum eigenvalue of the judgment matrix and the corresponding eigenvector, so as to provide a basis for the selection of the best scheme. The principle of AHP is applicable to the selection of the optimal scheme under different scenarios in this paper, which is generally divided into three levels: the establishment of hierarchical model (the analytic hierarchy process model generally includes three levels: the target level, the criterion level, and the scheme level); construction of judgment matrix (construction of judgment matrix according to the importance of each factor); hierarchical sorting and consistency test (to judge the effectiveness of the constructed judgment matrix, it is necessary to test the consistency of the judgment matrix) four steps.

2.4. Establishment of Multiobjective Model

(1) Establishment of decision variables

Considering the vast watershed area and the differences in climate and socioeconomic data among regions, this paper divides the watershed into 6 regions according to administrative regions, with a total of 36 decision variables, as shown in Table 2.

(2) Calculation of objective function parameters

Calculation of GDP per unit area of different land types in each scenario: according to the GDP of various industries and the area of various land use types in previous years, the GDP per unit area of different land use types in different regions in 2020 is shown in Table 3. Considering the development of social economy and combined with the growth rate of GDP per unit area in previous years, this paper sets the growth rate of GDP per unit area of cultivated land, grassland, forest land, and water area at 2020a-2035a and 2035a-2050a as 1%/a. Set the GDP growth rate of construction land in 2020a-2035a as 8.6%/a; the GDP growth rate of construction land from 2035a to 2050a is 5.9%/a.

Calculation of ecological green equivalent of different land use types: in order to evaluate the ecological green equivalent of different land use types in a river basin, the ecological service functions of various land use types in the basin are scored by experts. See Table 4 for the scoring Table of ecological function.

The total ecological function scores of cultivated land, grassland, forest land, and water area are 127.7, 137.74, 172.24, and 141.8, respectively, and the ecological service function scores of construction land and unused land are 0. Set the forest land score as 1 and normalize the scores of other types. The full planting coefficient of cultivated land and grassland is taken as 0.46. To sum up, the ecological green equivalent per unit area of each land use type in the basin is shown in Table 5.

(3) Constraint parameter settings

Table 9: Multiobjective function values and water supply and demand relationship in each scenario.

Time	Scene	Economic performance GDP (10^8yuan)	Social benefits water benefits (yuan/m^3)	Ecological benefit ecological green equivalent (km^2)	Water demand (10^8m^3)	Available water supply (10^8m^3)
2018	Actual	592.42	11.04	9206.6	53.65	46.04
2020	Current year	648.13	13.73	9215.89	47.2	47.2
2035	RCP4.5	2030.61	40.23	9203.3	50.48	50.48
	RCP8.5	2052	40.11	9229.51	51 .16	51 .17
2050	RCP4.5	5323.15	105.09	9350.32	50.65	52.36
	RCP8.5	5399.7	104.78	9375.9	51.53	53.61

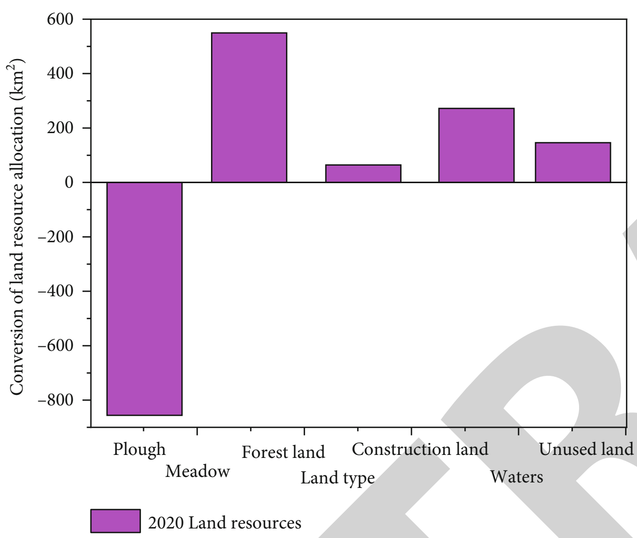

Figure 3: Land resource utilization and transformation in the current planning year of the basin (2020).

All scenarios ensure that the forest land and water area of the whole basin will not be reduced, and at the same time, taking into account social and economic development, to ensure that the construction land area of each administrative region of the basin will not be reduced [14].

2.5. MOGWO Parameter Setting. See Table 6 for parameter setting of the multiobjective Gray wolf algorithm.

2.6. Criteria Established for the Sustainability of Water and Soil Resources, Ecological Services, and Environmental Impact Assessment Indicators. Regarding the measurement theory of sustainable utilization of water resources, it is believed that the ultimate realization of sustainable utilization of water resources is the embodiment of the functions of the entire water resources-ecological environment-socioeconomic complex system in the basin (region) where it is located, and only the orderly and stable evolution of the system can be achieved in order to make the system sustainable. The selection of groundwater sustainability evaluation indicators should consider the complete requirements of the composite system, reflecting the ecological environment stability, water resource balance, and socioeconomic sustainability of groundwater. The establishment of groundwater sustainability evaluation indicators should follow unified principles and standards to facilitate the comparative analysis of research results. The standards are as follows:

(1) Evaluation indicators should be formulated on a regional scale

(2) The formulation of evaluation indicators should focus on the hot and contradictory issues that people are concerned about and clarify the relationship with groundwater sustainability

(3) Evaluation indicators should cover all resource types as much as possible

(4) The number of indicators should be small and precise, which can explain the problem and make it easy for all relevant parties to accept

(5) Indicators should be easy to quantify and based on scientifically rigorous data

The design of the index considers the three aspects of groundwater stability, water resource balance, and socioeconomic sustainability. Whether the calculated value meets the evaluation standard of a single index is used to quantitatively characterize the sustainability.

3. Result Analysis

3.1. AHP Weight Calculation. The importance of each parameter of the target parameter layer to the target is divided into five categories (Table 7), and a judgment matrix is established to determine the relative weight of each target in each time period, so as to provide a basis for the optimization of multiobjective schemes. In order to ensure the effectiveness of the weight, the consistency index is used to test the consistency of the results. When the coefficient of variation is less than 0.1, the consistency of the matrix is considered acceptable. Table 8 shows the proportion and inspection indicators of the three objectives in each of the three planning years calculated by the analytic hierarchy process, which are less than 0.1. As can be seen from Table 8, with the increasing attention paid to ecological protection, the weight of economic objectives will gradually decline, and the weight of ecological objectives will rise accordingly [15, 16].

Table 10: Allocation proportion of water resources in the basin under each scenario (%).

Scene	Time	Cultivated land	Grassland	Woodland	Construction land	Waters	Unused land	Total	Water demand/($10^8 m^3$)
Present situation	2018	80.7	0.1	9.3	2.6	7.3	0	100	53.65
Short-term planning	2020	75.4	0.2	10.9	3.7	9.9	0	100	47.2
RCP4.5	2035	71.3	0.2	10.9	6.7	10.9	0	100	50.48
	2050	68.4	0.2	12.2	6.5	12.8	0	100	50.65
RCP8.5	2035	71 .1	0.2	11.9	6.7	10.1	0	100	51 .16
	2050	68.3	0.1	13.3	6.6	11.7	0	100	51.53

Table 11: Allocation area of land resources in the basin under each scenario (km^2).

Scene	Time	Cultivated land	Grassland	Woodland	Construction land	Waters	Unused land	Total
Present situation	2018	5350	14778.3	1395.2	928.2	639.3	12996	36088.5
Short-term planning	2020	4400	15323.3	1429.9	1181.9	756.6	12996	36088.5
RCP4.5	2035	4303	15082.7	1457.4	1392.1	856.5	12996	36088.5
	2050	4500	14296.1	1718.5	1586	990.2	12996	36088.5
RCP8.5	2035	4301	15021.5	1556.9	1416.7	795.4	12996	36088.5
	2050	4502	14215.6	1845.1	1625.8	902.6	12996	36088.5

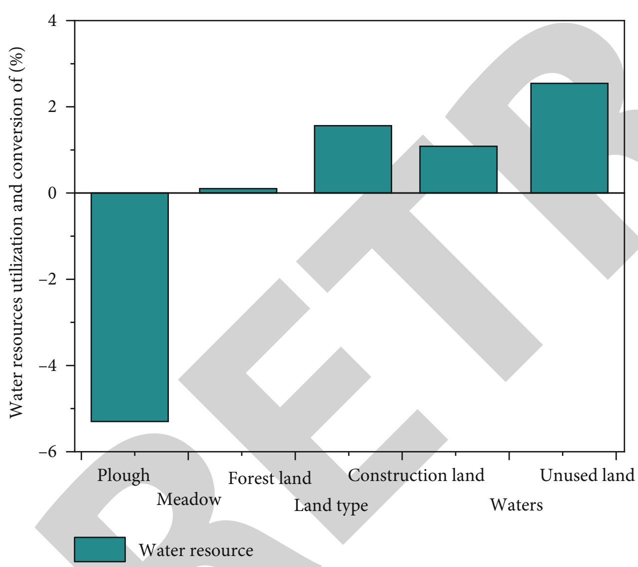

Figure 4: Water resources utilization and transformation in the current planning year (2020).

3.2. Configuration Result Analysis. Establish multiobjective models under 2020 (current situation), RCP4.5 2035, RCP4.5 2050, RCP8.5 2035, and RCP8.5 2050, solve the models by MOGWO, respectively, and optimize the optimal scheme based on the weight of each objective function determined by AHP. See Table 9 for the objective function values of each scenario.

It can be seen from Table 9 that under the current situation, the water shortage of the basin is $7.61 \times 10^8 \, m^3$. In order to meet the current water supply and demand balance of the basin, and taking into account the ecological protection of the basin, the basin should reduce the corresponding agricultural water use. As shown in Figure 3, this goal can be achieved by reducing the area of cultivated land in the basin [17, 18]. Through optimization in this paper, the values of the three objective functions will increase in the current (2020) planning year. Under RCP4.5 scenario, the ecological green equivalent will decrease to a certain extent in 2035 compared with the current planning year, and the decrease value is equivalent to the ecological green equivalent of 12.59 forest land. The main reason is that the temperature rises and the ecological water consumption of the basin increases. By 2050, although the crop water demand will continue to increase, with the increase of water-saving irrigation area and the improvement of irrigation water utilization rate, the total water demand of the basin will not increase significantly. Under the condition that the changed range of various land areas does not exceed 20%, there will be a certain surplus in the supply of water resources in the basin, providing more water for ecological protection in the Tarim River Basin downstream of the basin. Through allocation, the area of forest land and water area in the basin will continue to increase, and the water allocation of forest land and water area will also increase correspondingly. See Table 10 and Table 11 for the current situation of water and soil resources in the whole basin and the specific data of water and soil resources allocation in the basin under the four scenarios.

Figures 3 and 4 show the detailed transformation of water and soil resources in the basin under the current situation. It can be seen that the reduced cultivated land area is mainly used to meet the construction land for social and economic development and the grassland and water area for ecological protection, while the increased area of forest

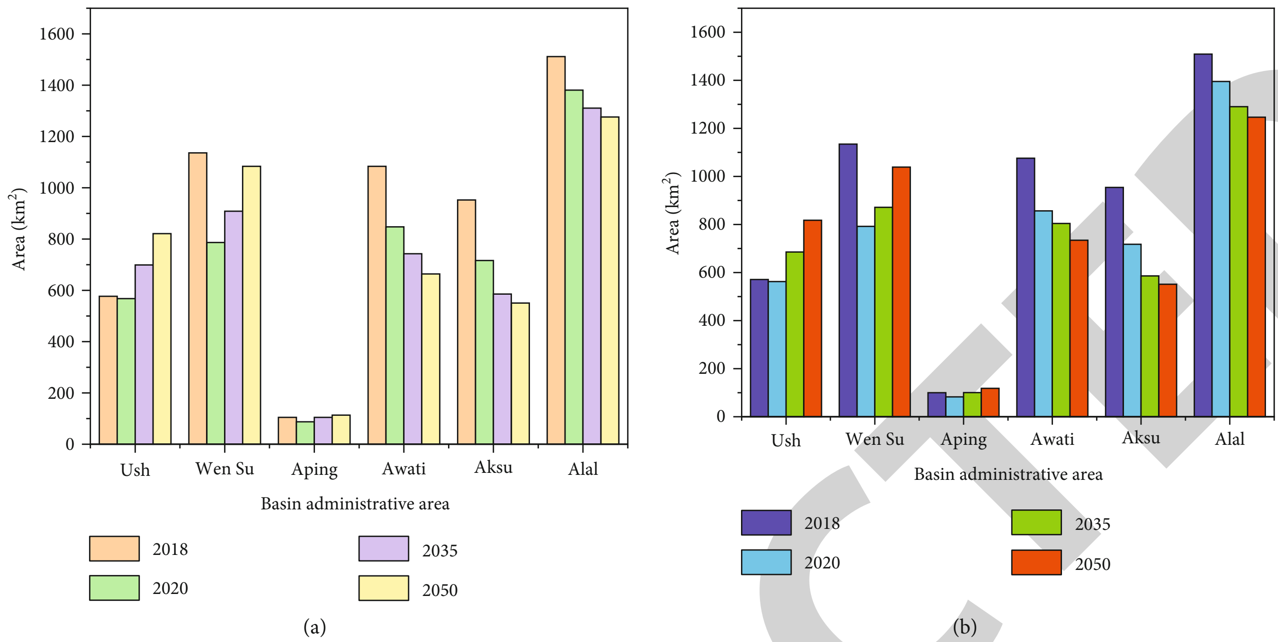

Figure 5: Cultivated land allocation in various regions of the basin under various scenarios ((a) is RCP4.5; (b) is RCP8.5).

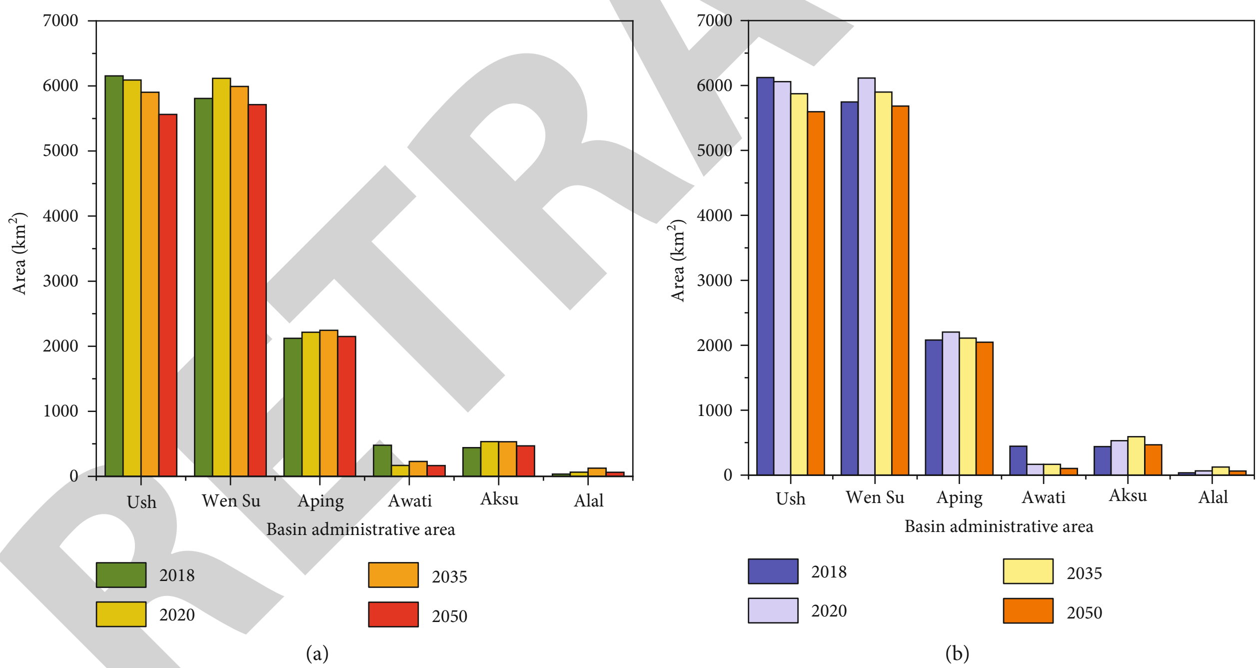

Figure 6: Grassland configuration in each region of the basin under each scenario ((a) is RCP4.5; (b) is RCP8.5).

land is relatively small due to high water consumption [19, 20]. At the same time, with the reduction of cultivated land area, the proportion of cultivated land water distribution in the basin will also drop by about 5.3%, and more water resources will be allocated to the ecological protection of the basin.

Although the total allocation of cultivated land area in the basin is similar under the two climate scenarios, the change of cultivated land area in each county in the basin is different. See Figures 5(a) and 5(b) for cultivated land allocation in each basin under the two emission concentrations. Among them, the cultivated land area of county D, city E, and city F shows a continuous downward trend, which is in line with the basic planning direction of "well killing and field shrinking" in the basin. The difference is that the cultivated land area of county A has increased continuously, which is due to the different water demand per unit area of cultivated land in each county under the two scenarios, and the multiobjective model will produce a game when considering the benefits of one cubic meter of water and the total amount of water demand. Due to the large proportion of cultivated land and grain crops in county A, the output value of cultivated land per unit area is lower than that in other regions [21, 22]. At the same time, its water demand per unit area is also smaller than that in other regions. Under the background of basin water volume constraints and cultivated land red line constraints, Wushi cultivated land "less water" has a greater impact on the comprehensive benefits of the whole basin than "low output value", so its cultivated land area will show an increasing trend. As can be seen from Figures 6(a) and 6(b), the results of grassland allocation in various regions of the basin are mainly reflected in Wushi and Wensu regions. The former shows a downward trend, while the latter shows an upward and then downward trend. At the same time, taking into account the principle of ecological protection, the forest land and water area of each county are showing an upward trend.

To sum up, it can be seen that there are differences in water demand and water supply conditions under the two climate scenarios, which have a great impact on the configuration results. Decision makers need to choose a reasonable configuration scheme according to their preferences under different climatic conditions.

3.3. Problems Existing in the Sustainable Development and Utilization of Water Resources

3.3.1. Serious Soil Erosion and Large Sediment Content in Rivers. Due to the limitation of natural conditions and long-term human activities, Chinese forest coverage rate is low and soil erosion is serious. The loss of water leads causes large sediment content in many rivers. For example, the average annual average sediment content of the Yellow River is 37.7 kg/m^3, and the annual sediment transport is 1.6 billion t, ranking the first in the world. A large number of soil erosion, not only caused the loss of cultivated land area reduced, the decrease of fertility, and the river sediment content increased but also a large number of sediment deposition resulting in the reservoir deposition and river bed rise, and even some river sections have developed into aboveground rivers, affecting the development and utilization of water resources. Natural factors (such as loose soil quality and large precipitation variation rate) are the main causes of soil erosion. Due to the ever-increasing Chinese population, especially in One. In some economically underdeveloped areas, in order to get rid of poverty as soon as possible, a large number of deforestation, overgrazing, and unplanned mining, resulting in serious damage to the regional vegetation, aggravated the soil erosion. The production, transportation, and deposition of river sediment have a great impact on the national economy. Although the river sediment can improve the soil in the irrigated area through silt irrigation, a large number of soil erosion reduces the farmland area and fertility, siltation rivers and reservoirs, shorten the service life of water conservancy facilities, and increase the difficulty of development and utilization of water resources.

3.3.2. Water Pollution Is Serious. Water pollution, destroyed the water ecosystem, make the quality of aquatic products decline, yield decline, and even some aquatic life extinct, for example, Chinese sturgeon, shad, baiji dolphin, and so on. Serious water pollution also affects the quality and output of industrial products, and it is even forced to stop production because of the deteriorating water quality. The intensification of pollution makes the contradiction between the original tight supply and demand of China's water resources more prominent, and water pollution has become the main obstacle factor restricting the sustainable and stable development of China's national economy.

4. Discuss

4.1. Sustainable Development and Utilization of Water Resources

4.1.1. Protect Water Sources and Pay Equal Attention to Pollution Prevention and Water Conservation. In the case of increasing the shortage of water resources, to ensure the sustained and stable growth of the national economy, preventing pollution and saving water are the key measures to alleviate the current situation of water supply and demand. Therefore, it is necessary to strengthen water ecological environment protection, build water conservation forest and water conservation shelter forest in upstream and downstream, prohibit blind reclamation, protect fish and other aquatic life, prevent water quality deterioration, delimit water environment functional areas, formulate administrative cross boundary water quality control standards, define water resources implementation responsibilities, implement total control and discharge permit system for designated water environment protection areas, improve water environment quality standards, and formulate pollutant discharge time standards and production process standards. In agricultural production, we should control the input of pesticides and chemical fertilizers and strictly control the pollution of industrial wastewater, solid waste, and toxic and harmful substances. Comprehensive implementation of water conservation is the most realistic and effective measure to alleviate the contradiction between water supply and demand.

4.1.2. Gradually Build the National Water Resources Allocation Project Pattern. On the basis of comprehensive water saving, we will accelerate the construction of the first phase of the middle route of the eastern route of the South-to-North Water Diversion Project and the supporting projects, carry out the preliminary work of the western route of the South-to-North Water Diversion Project in time, gradually build a national macroallocation pattern of water resources, and effectively solve the problem of water shortage in northern China. On the premise of protecting the ecological environment and making full demonstration, some regional water resources allocation projects and necessary reservoir projects should be appropriately built, especially strengthening the construction of key backbone water source projects and small rural water conservancy facilities in southwest China, so as to improve the water supply guarantee capacity and drought resistance and water storage capacity. On the basis of comprehensive consideration of regional water resources conditions, river system distribution, project layout characteristics, and ecological environment impact, we will study and implement the connection of rivers, lakes, and reservoirs according to local conditions and give full play to the function of water resources allocation of river and lake water systems. We will strengthen the scientific operation of water resources, gradually improve the water resources operation system, strengthen the optimal operation of reservoirs and the comprehensive operation of water resources in cascade reservoirs, coordinate external water transfer and local water, surface water, and groundwater, attach importance to ecological operation, and allocate water resources rationally and efficiently. To ensure the safety of urban water supply, we will vigorously strengthen urban water saving, rationally allocate regional water resources, strengthen the construction of urban water supply sources and standby water sources, and improve the emergency response capacity of urban water supply. To ensure the safety of water supply in key areas, we will ensure the safety of water supply in the key national economic zones and energy bases such as the Yangtze River Delta, Pearl River Delta, and Bohai Rim by comprehensively strengthening water conservation, improving the capacity of water source regulation and storage, implementing necessary cross-basin water diversion, and increasing sewage treatment and reuse and seawater utilization.

5. Conclusion

This paper optimizes the allocation of water and soil resources in a river basin with different climate scenarios and time nodes. Firstly, a multiobjective model with the total GDP of the basin, the benefit of water use per cubic meter and the total ecological green equivalent as the economic, social, and ecological objectives is established. The Pareto solution set of the multiobjective model is obtained by using the MOGWO algorithm, and the solution set is optimized by AHP, and finally the optimal solution in line with different decision preferences under different scenarios is obtained. The results show that the current basin is in a state of water shortage, with a total water shortage of 7.61×10^8 m^3.

In order to cope with the situation of water shortage and protect the ecosystem of the basin, the cultivated land area should be reduced by about 950.7 km^2 (17.8%) in the current planning year. The reduction of cultivated land area is mainly manifested in three areas: county B, city E, and county D, with the reduction area of more than 200 km^2. Under the two RCP scenarios, the water shortage scenario in the recent planning year (2035) will continue, and it is necessary to continue to reduce the cultivated land area by about 100 km^2. The total GDP and ecological green equivalent in RCP8.5 scenario are slightly higher than those in RCP4.5 scenario, because the water demand is higher, and the benefit of unilateral water use is smaller in RCP8.5 scenario. With the improvement of the water saving ratio and irrigation water utilization coefficient, as well as the increase of the water inflow of the basin, the water shortage situation of the basin will be improved to a certain extent in the long-term planning year (2050), and the cultivated land area of the whole basin can be increased by about 200 km^2 compared with 2035.

In general, comparing the magnitudes of the three objective functions of the optimal solution in the same period, it is found that the RCP8.5 scenario may be more suitable for the economic development and ecological protection of a certain river basin, but the intensification of the greenhouse effect may bring about other negative impacts, which should be adjusted according to different conditions. Take reasonable measures to respond to the situation. Lakes are an important part of water resources. In the future, fresh water resources in lakes can be rationally exploited and utilized, and various economic benefits can be obtained. In the past, we developed lake to build land blindly. The lake area decreased year by year in the whole country, which led to the reduction of water surface, the decline of water level, and the deterioration of water environment, which also caused the lakeshore beach bare leakage and expanded desertification land. Therefore, the blind reclamation of the lake is not worth the loss. China's water shortage, the development potential is limited, water efficiency is not high, environmental problems cannot go the traditional way to supply for and must accelerate the water supply management to water management in water resources planning, configuration, conservation, and protection, each link should reflect the concept of water management, the connotative development path.

Data Availability

The labeled data set used to support the findings of this study is available from the corresponding author upon request.

Conflicts of Interest

There are no conflicts of interest.

Acknowledgments

This work is supported by the Pusan National University, the Inner Mongolia University of Science and Technology, and Jeonju University.

References

[1] J. Feng, "Optimal allocation of regional water resources based on multi-objective dynamic equilibrium strategy," *Applied Mathematical Modelling*, vol. 90, pp. 1183–1203, 2021.

[2] A. So, A. Dte, and B. Lbr, "Cargo allocation and vessel scheduling on liner shipping with synchronization of transshipments," *Applied Mathematical Modelling*, vol. 77, pp. 235–252, 2020.

[3] C. Lamnatou and D. Chemisana, "Solar thermal systems for sustainable buildings and climate change mitigation: recycling, storage and avoided environmental impacts based on different electricity mixes," *Solar Energy*, vol. 231, pp. 209–227, 2022.

[4] A. Rehman, H. Ma, M. Ahmad, M. Irfan, and A. A. Chandio, “Towards environmental sustainability: devolving the influence of carbon dioxide emission to population growth, climate change, forestry, livestock and crops production in Pakistan,” *Ecological Indicators*, vol. 125, p. 107460, 2021.

[5] G. Li, F. Liu, A. Sharma et al., “Research on the natural language recognition method based on cluster analysis using neural network,” *Mathematical Problems in Engineering*, vol. 2021, Article ID 9982305, 13 pages, 2021.

[6] T. H. Christensen and V. Bisinella, “Climate change impacts of introducing carbon capture and utilisation (ccu) in waste incineration,” *Waste Management*, vol. 126, pp. 754–770, 2021.

[7] B. Dca, C. Hz, and D. Jl, “Impacts of climate change on groundwater in the great lakes basin: a review,” *Journal of Great Lakes Research*, vol. 47, no. 6, pp. 1613–1625, 2021.

[8] L. A. Dan, B. Jz, B. Gw, B. Xw, and A. Jw, “Impact of changes in water management on hydrology and environment: a case study in North China – science direct,” *Journal of Hydro-Environment Research*, vol. 28, pp. 75–84, 2020.

[9] B. Zaa, B. Lb, C. Mj, and D. Gr, “Geospatial and statistical interpretation of lineaments: salinity intrusion in the Kribi-Campo coastland of Cameroon,” *Advances in Space Research*, vol. 66, no. 4, pp. 844–853, 2020.

[10] C. M. Yu, M. Tala'T, L. H. Shen, and K. T. Feng, “A multi-objective model checking for transmission policy optimization in hybrid powered small cell networks,” *IEEE Access*, vol. 8, pp. 71339–71352, 2020.

[11] Z. Wang, T. Luo, M. Li, J. T. Zhou, and L. Zhen, “Evolutionary multi-objective model compression for deep neural networks,” *IEEE Computational Intelligence Magazine*, vol. 16, no. 3, pp. 10–21, 2021.

[12] G. Liu, Y. Zhu, and W. Jiang, “Dynamic economic emission dispatch with wind power based on improved multi- objective brain storm optimisation algorithm,” *IET Renewable Power Generation*, vol. 14, no. 13, pp. 2526–2537, 2020.

[13] J. Yang, X. Hou, Y. Liu, H. U. Yuhen, and Q. Pan, “A two-level scheme for multiobjective multidebris active removal mission planning in low earth orbits,” *SCIENCE CHINA Information Sciences*, vol. 65, no. 5, pp. 1–16, 2022.

[14] A. Kumar, A. Gupta, and A. Mehra, “A bilevel game model for ascertaining competitive target prices for a buyer in negotiation with multiple suppliers,” *RAIRO - Operations Research*, vol. 56, no. 1, pp. 293–330, 2022.

[15] C. Gruber, P. Raninger, M. Stockinger, and C. Bucher, “Multi-class grain size model for forged alloy 718 aircraft parts,” *Materials Science Forum*, vol. 1016, pp. 499–508, 2021.

[16] L. Torres, C. L. Castro, H. P. Rocha, G. M. Almeida, and A. P. Braga, “Multi-objective neural network model selection with a graph-based large margin approach,” *Information Sciences*, vol. 599, pp. 192–207, 2022.

[17] H. Faris, A. A. Heidari, M. M. Mafarja, P. A. Castillo, and I. Aljarah, “A robust multi-objective feature selection model based on local neighborhood multi-verse optimization,” *IEEE Access*, vol. 9, pp. 100009–100028, 2021.

[18] H. Xie, Y. Wang, Z. Gao, B. Ganthia, and C. Truong, “Research on frequency parameter detection of frequency shifted track circuit based on nonlinear algorithm,” *Nonlinear Engineering*, vol. 10, no. 1, pp. 592–599, 2021.

[19] R. Huang and X. Yang, “Analysis and research hotspots of ceramic materials in textile application,” *Journal of Ceramic Processing Research*, vol. 23, no. 3, pp. 312–319, 2022.

[20] X. Liu and Z. Ahmadi, “H2O and H2S adsorption by assistance of a heterogeneous carbon-boron-nitrogen nanocage: computational study,” *Computational Study*, vol. 21, no. 1, pp. 185–193, 2022.

[21] J. Jayakumar, S. Chacko, and P. Ajay, “Conceptual implementation of artificial intelligent based E-mobility controller in smart city environment,” *Wireless Communications and Mobile Computing.*, vol. 2021, pp. 1–8, 2021.

[22] A. Sharma and R. Kumar, *A Framework for Pre-Computated Multi- Constrained Quickest QoS Path Algorithm*, 2017.