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Research Article

Construction of Ecological Compensation System for Water Environment Resource in Public Places Using Grey Correlation

Xinhe Xin

Inner Mongolia Vocational College of Chemical Engineering, Huhhot 010000, China

Correspondence should be addressed to Xinhe Xin; xinxinhe@mjwhedu.cn

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In the geographical locations where drinking water sources are available, ecological compensation is a potent environmental economic tool for conservation of the environment. The existing systems cannot analyze the extent of ecological damage to water environment resources due to the increase in compensation cost and reduction in compensation efficiency. Therefore, an ecological compensation system of natural water resources in public places is proposed in this paper for preserving one of the most important natural resources, "water." The system obstacles in the implementation of ecological resource compensation mechanisms for water protection regions of public places are analyzed using grey relational analysis. The status of payment and benefits in the upstream and downstream sections of public places is determined on the basis of a study of compensation theory. Then, the ecological compensation system of the river basin is established by calculating accommodation of water footprint model. Moreover, the key factors of the extent of ecological damage to water environment resources in public space are analyzed by an improved grey relational analysis method. The water footprint model has analyzed the safety and pressure analysis of water resources in public attractions places. The results are retrieved in a simulated environment which shows that the designed system can effectively enhance the compensation efficiency and reduce the compensation costs. The ecological compensation system is developed to actualize the economy and natural resources for the sustainable growth.

1. Introduction

Ecological compensation is an institutional framework that regulates the interests of relevant people, mostly via economic methods, with the goal of maintaining and using ecological services in a sustainable manner. The water-energy resource, nation, society, and development enterprises, as well as the resource's location, are all subjects of ecological compensation. In today's environment, the problem of global water resources shortage and water quality deterioration is increasingly severe. The development and utilization of water resources in protected areas is related to the social and economic development of entire river systems [1], which will make an extensive and far-reaching impact. The continuous influence of social and economic activities has tipped the dynamic balance of water source protection areas and reduced normal ecological service function. Therefore, massive human, material, and financial resources have been invested in ecological construction and water source protection. Meanwhile, the production layout and industrial selection have been strictly restricted. However, this has seriously hindered the economic development and the improvement of people's living standards. The contradiction between environmental protection and economic growth has been increasingly apparent [2, 3]. Therefore, it is necessary to accelerate establishing and improving the ecological compensation system in the water source protection area. Also, we need to establish the balance between the obligations and rights of all stakeholders and straighten out the ecological interest relationship between the water source protection area and the use area. In this way, the national development and utilization of water resources and the sustainable development of the economy and society can be achieved.

In recent years, many places have started the practice of ecological compensation for the water source protection areas in the basin. As the source of the Dongjiang River, the ecological compensation mechanism of Jiangxi Province has also been explored and tried. Relevant experts have researched the establishment of an ecological compensation system for the water environment and resources. In [4], the authors have studied the ecological compensation problem of primary watersheds where the water environment has been seriously damaged. The ecological compensation strategy was analyzed step by step through the evolutionary game models in three situations. The study concludes that an eco-compensation pattern including both upper and downstream government will be proven to be the best option for a basin with a severely damaged water environment. In [5], the authors have researched the serious damage to the groundwater environment and the lack of incentive and guarantee mechanism for groundwater protection and restoration and then established and improved the ecological compensation mechanism for groundwater protection, which has realistic meanings. In [6], the authors have established the water footprint and ecological compensation standard model that provides a scientific basis for establishing ecological civilization demonstration area and regional ecological compensation mechanism. The compensation system in [6] has achieved significant research results at this stage, but the compensation cost is more, and the compensation efficiency decreases because the ecological damage degree of the water environment and resources is not considered.

The current ecological compensation is still in the primary stages, so many problems are inevitable in the practice process. The laws and regulations of ecological compensation are insufficient. It is difficult to determine the compensation standard. The way of compensation is single, so it needs to be diversified. In addition, it is challenging to raise funds for ecological compensation. The cooperation and coordination mechanism of environmental compensation departments is not perfect. So a proper ecological compensation system for water resources is the need of the society, which should be efficient and of a low cost. Therefore, the ecological compensation system of water environment resources in public attractions places is proposed in this paper. The highlights are given as follows:

(i) Ecological compensation system is discussed in detail.

(ii) Analysis of the extent of damage to water environment resources based on the improved grey relational is analyzed.

(iii) Security measurement and pressure analysis for water environment and resources in tourist attractions is discussed and evaluated.

(iv) Based on the analysis and evaluation, an ecological compensation system of water environment resources is proposed, which increases policy compensation, increases capital compensation investment, and promotes project and industrial compensation.

(v) Simulation results show that the proposed method can effectively improve compensation efficiency and reduce costs.

The next section discusses the construction of the ecological compensation system for water environment resources based on improved grey relational analysis. The third section elaborates on simulation results, and the fourth section concludes the paper.

2. Ecological Compensation System for Water Resources

2.1. Ecological Compensation System of Water Environment Resources. China Council for International Cooperation on Environment and Development points out the concept of ecological compensation: it is a public system arrangement to protect the ecological environment and promote the harmonious development of humans and nature. According to the value of ecosystem services, the cost of environmental protection, and the cost of development opportunities, government and market means are used to regulate the interesting relationship between stakeholders of ecological conservation. Some scholars have defined ecological compensation in a narrow sense and broad sense. In a narrow sense, ecological compensation refers to a series of activities taken by human beings to protect and repair the ecological environment damage and pollution caused by the development and utilization of natural resources. In a broad sense, the ecological compensation should also include the compensation for lost development opportunities to protect and construct an ecological environment. The government can provide compensation for the residents in terms of capital, technology, and material objects and provide the residents in water source areas with preferential policies or scientific research funds to improve the environmental protection awareness of the residents [7].

Generally, the ecological compensation mechanism is to regulate the interesting relationship of relevant parties in the use and protection of the ecological environment based on the cost of ecological protection and construction through the government predominance, market trading, and public participation, internalize the external effect of ecological environment utilization or protection behavior, and maintain and thus improve the means or public institutional arrangements for the sustainable use of ecosystem services.

The water source protection region is a special area that integrates natural resources and ecological attributes to protect the water body. The ecological environment of most water source protection regions is relatively fragile. In addition, they have to respond to ecological environment construction and protection. It will inevitably affect the economic development of water source protection regions to a certain extent, resulting in the partial or total loss of development rights. Therefore, other regions should also be able to enjoy the ecological services. Therefore, the ecological compensation of water protection areas should include two aspects: the first one is protection compensation, which refers to the compensation for the protection and construction of the ecological environment in water protection areas. The other is development compensation, which refers to the compensation for the lost development opportunities to protect the ecological environment, including financial reduction caused by local government investment in ecological construction, cost increase caused by the development of ecological industry, and ecological migration [8].

The meaning of ecological compensation in water protection areas should be summarized based on the guidance of sustainable development theory. The water source area should be protected and restored to maintain the sustainable development of ecological service function. At the same time, some policies and legal means are used to regulate the interesting relationship between stakeholders of environmental protection. The beneficiaries of eco-environmental protection in the water protection area should pay the corresponding expenses so that the externality of ecological protection in the water source area is internalized. Then, the ecological environment of the water source protection area can be protected, and the value of the ecological service function can be increased.

Watershed is the basic characteristic of existence mode of water resource, and most of China's water source protection areas have this characteristic. Therefore, the ecological compensation of the water conservation area should be based on the watershed concept. Under the watershed background, the ecological compensation of the water source protection area is mainly the compensation from developed regions to less developed regions. Finally, the sustainable and harmonious development of the whole basin can be achieved.

The ecological environment of the watershed provides a lot of resources for the development of human society and the economy. In the process of exploitation and utilization of resources, a certain externality inevitably appears. The builder of ecological protection invests a lot of workforce, materials, and financial resources to build and protect the ecological environment [9, 10]. This increases the local government's financial burden and restricts the development of polluting enterprises, thus affecting the social and economic development and the improvement of living standards in the upstream area. However, good ecological protection in the upstream area can provide the downstream area with sufficient water quantity. This shows an obvious positive externality. In order to overcome this externality, it is necessary to build an ecological compensation system for a watershed and strengthen the economic compensation between the upper and lower reaches. That is to realize the internalization of external effects. As a beneficiary, the lower reaches must pay the compensation to the upstream area. Suppose the production and living behaviors of the upper reaches lead to the pollution of the downstream area [11]. In that case, they must pay compensation to the government and people of the downstream area to control the pollution.

According to microeconomics theory, social products can be divided into public goods and private goods. The idea of public goods originated in Austria and Italy in the nineteenth century. Public goods are a kind of product for people to consume together. Its classical definition was given by Paul Samuelson in his famous article "The Pure Theory of Public Expenditure" in 1954. He said, "Everyone's consumption of this product will not lead to the reduction of other people's consumption of the product."

Public goods have two basic characteristics:

(1) Noncompetition of consumption.

The noncompetition of consumption means that public goods meet the public needs of the whole society, not just individual needs. Everyone can enjoy public goods but cannot prevent other people from enjoying consumption. Adding a consumer will not reduce anyone's consumption of public goods. That is to say, the marginal production cost of public goods is zero.

(2) Nonexclusiveness of benefits.

The nonexclusiveness of benefits means that it is technically impossible to exclude the people who refuse to pay from the scope of public goods, and it needs to cost a lot to exclude those people. That is to say, the people who have not paid for public goods can also enjoy the public goods.

There are two types of public goods:

(1) Pure public goods.

Pure public goods refer to the goods which are exclusive and uncompetitive [12].

(2) Quasipublic goods.

Quasipublic goods refer to goods with only one of two characteristics.

In real life, there are fewer pure public goods that meet the two conditions simultaneously, and most of them are noncompetitive and nonexclusive quasipublic goods.

The water resource is a kind of public resource belonging to quasipublic goods, and it is highly competitive. During the development and utilization of water resources, there are some problems such as "the tragedy of the commons," overuse, hitchhiking psychology, and insufficient supply. In order to solve these problems, it is far from enough to rely on government regulation and payment. It is necessary to establish an ecological compensation system to balance the interests of protectors and beneficiaries to arouse the enthusiasm of water resource protectors effectively.

The natural resource refers to all the natural materials and conditions that can be used for human survival, development and enjoyment, and the natural environment and artificial environment formed by the interaction of natural materials and natural conditions. The natural resource is valuable, which depends on the utility, scarcity, and development condition of natural resources to human beings. Therefore, it includes three aspects of value [13]:

(1) The inherent value of the natural resource (the value of natural value without human labor) depends on the utility and rarity of natural elements.

(2) The intrinsic value of a natural ecosystem is the functional value of natural elements to the ecosystem, including the ecological balance and the virtuous cycle of an ecosystem.

(3) The value obtained by the development and utilization of natural resources, including the investment of humans, protects and constructs the ecological environment.

The ecological compensation system is one of the contents of the paid use system of a natural resource. The so-called paid use of natural resources means that the use and development of natural resources are not free of charge. The developer of natural resources and the people who benefit from the utilization of natural resources must pay fees to the owner of a natural resource and the person who has made contributions or paid for natural resource protection. Water resource belongs to the natural resource [14, 15], so the principle of paid use must be followed in the process of development and utilization.

(1) Water resource has economic value and ecological value. In order to obtain the right to use water resources, developers must pay a certain amount of money to the owner of the water resource.

(2) The people who have made contributions to the protection of water resources should be compensated accordingly, and the beneficiaries should pay this compensation.

In the face of the increasingly serious problem of the ecological environment, practitioners and theorists worldwide have conducted in-depth research on how to deal with it and have tried various modes such as market regulation, government enforcement, and enterprise self-management. After some time, each ecological governance model will fall into difficulties. Therefore, a considerable proportion of scholars put forward the cooperative governance mode of the ecological environment to achieve the negotiation of the governance process and the effectiveness of governance results.

The comparative analysis of the concepts, advantages, and disadvantages of the above modes shows that the cooperative governance mode is undoubtedly a breakthrough. The cooperative governance mode of ecological environment not only hopes that the government will continue to play a leading role but also expects the positive role of market regulation to give full play to the advantages of social multigovernance subjects and thus to promote the level and ability of ecological environment governance. In eco-environmental governance, it is necessary to reshape the existing and new governance subjects inside and outside the systems through cooperative governance mode. The government should also provide a relatively loose environment [16] to reduce the constraints on other governance subjects. Meanwhile, the government should train and guide the subjects and thus realize the "good governance" of the ecological environment through more channels.

2.2. Analysis of the Extent of Damage to Water Resources Using the Improved Grey Relational Analysis. As an important carrier of public attraction places activities, the water resource plays a vital role in the sustainable development of tourism. Gosling pointed out that water shortage is an essential constraint for public attraction places development. Many public facilities, such as swimming pools, golf courses, and hot springs, will not be available for us without water. As the most vulnerable factor in the tourism ecological environment, water resource security is affected by many factors [17, 18]. The quantitative analysis of the factors influencing the security of water resources in tourist areas can help us understand the influence degree of various factors on water resource security. The grey correlation analysis method proposed is based on the grey theory. According to the similarity or difference of development trend of factors, the grey correlation analysis measures the correlation between factors. Because the development trend is taken as the foothold, it is also applicable to a few samples and irregular samples.

The security system of water resources in tourism areas is a complex grey system. Due to the interference of human tourism activities, this system shows intense uncertainty and fuzziness. Therefore, the grey correlation analysis is used to quantitatively research the factors influencing water resource security in tourist areas, thus improving the accuracy. Traditionally, the grey correlation analysis can get the order and correlation of the influencing factors, but it is difficult to get the influence degree of each influencing factor and quantitatively explain the analysis results. Based on grey correlation analysis results, the influence degree of each factor can be quantitatively analyzed by the judgment matrix. The improved grey correlation analysis method is a system analysis method. The relevance is found from the feature data series reflecting the system behavior and the effective factors influencing the system behavior. The correlation degree is calculated by processing the data according to the partial information. Then the main factors affecting the system behavior and the differences of various factors influencing the system behavior are determined [19]. The influence degree of the factor is quantitatively described, and then the specific influence value of each factor is obtained. The data processing generally includes two steps:

(1) The reference sequence cluster $y_j(k)$ and comparison sequence $x_i(k)$ are determined.

(2) The data of reference sequence cluster and comparison sequence are nondimensionalized by the interval method.

If the larger is the best, the profitability index is given in the following equation:

$$zy_j(k) = \frac{y_j(k) - \min\left[y_j(k)\right]}{\max y_j(k) - \min\left[y_j(k)\right]}. \tag{1}$$

If the smaller is the best, the cost index is given by the following equation:

$$zx_i(k) = \frac{\max\left[x_i(k)\right] - x_i(k)}{\max x_i(k) - \min\left[x_i(k)\right]}. \tag{2}$$

(3) The grey correlation coefficient $\delta_{ji}(k)$ of reference sequence of the jth cluster is calculated and given in the following equation:

$$\delta_{ji}(k) = \frac{\min_i \min_k \left| zy_j(k) - zx_i(k) \right| + \rho \max_i \max_k \left| zy_j(k) - zx_i(k) \right|}{\left| zy_j(k) - zx_i(k) \right| + \rho \max_i \max_k \left| zy_j(k) - zx_i(k) \right|}. \quad (3)$$

In equation (3), ρ represents the resolution coefficient. $y_j(k)$ is the reference sequence cluster. $x_i(k)$ is the comparison sequence.

(4) The grey correlation degree of the reference sequence of jth cluster is shown in the following equation:

$$r_{ji} = \frac{1}{n} \sum_{k=1}^{n} \delta_{ji}(k). \quad (4)$$

(5) According to the correlation degree, the direct "quotient" method is used to compare the factors in pairs, and then the judgment matrix is constructed and given B in the following equation:

$$B = \begin{bmatrix} \frac{r_{j1}}{r_{j1}} \cdots \frac{r_{j1}}{r_{ji}} \\ \\ \frac{r_{ji}}{r_{j1}} \cdots \frac{r_{ji}}{r_{ji}} \end{bmatrix}. \quad (5)$$

(6) The ranking of influence degree is as follows:

The ranking of influence degree can be attributed to the problem of calculating the feature root and feature vector of the judgment matrix. Meanwhile, the feature root and the feature vector of the judgment matrix are calculated and given by the following equation:

$$\lambda_{\max} = \frac{1}{n} \sum_{k=1}^{n} \frac{B}{kW_i}. \quad (6)$$

In equation (6), W_i represents the influence degree of corresponding factor sort.

(7) Consistency test of judgment matrix is as follows:

In order to verify the consistency of the matrix, it is necessary to calculate the corresponding consistency index CI. The specific calculation is shown in the following equation:

$$\mathrm{CI} = \frac{\lambda_{\max} - n}{n - 1}. \quad (7)$$

n is the serial number.

The security of tourism water resources is affected by many factors. Based on the qualitative analysis of relevant experts on the factors influencing water resources security, we quantitatively analyze the influencing factors of water resources security according to the quantitative expression of subjective influencing factors. The scenic spot is a typical mountain tourist area from the objective aspect. The security of water resources is affected by natural conditions such as precipitation and vegetation and human activities. Therefore, the objective factors influencing water resources security in tourist attractions are analyzed from resource constraints, ecological constraints, and population constraints. The security of water resources in scenic spots also depends on the subjective initiative of managers. The subjective factors influencing water resources security in scenic spots are analyzed from technical and management constraints.

According to the characteristics of the scenic area, we can see that tourists, permanent residents, and staff are the main body of water demand and the main source of sewage. The development of tourism accommodation and catering activities depends on water resource supply [20]. With the improvement of leisure and enjoyment consciousness, the standard of accommodation becomes higher and higher, and the demand for water supply is also improved. The increase of tourism water consumption threatens the safety of tourism water and increases the tourism sewage. The sewage produced by the catering and accommodation of tourists and the domestic sewage of permanent residents and staff is the primary source of water sewage. These sewages are the domestic and tourism wastewater with high organic concentration, and the pollution source exists in the area of human activities. The feces and the leaching water are other sources of water pollution in the scenic area. From the perspective of pollution sources, every tourist is a pollutant emission source. With the increase of tourists, the pollution will be intensified. The population restriction, including the tourist volume and accommodation rate, is the main reason for high water consumption and sewage discharge.

The water required for ecology and the environment includes ecological water storage such as river water supply and vegetation conservation and environmental water use such as greening, ecological health, and fire protection. The ecological water storage in Huangshan scenic area is often directly transformed by rainfall, which will not bring too much pressure on the safety of water quantity. However, ecological water is a real water resource consumed and utilized in scenic areas. The forest fire is easy to happen in scenic mountain areas, especially in the dry season. Therefore, there are small fire pools near hotels and guest houses in scenic spots, and they are specially used for storing firewater. The flushing water from tourist public toilets is the occupation of water and the source of sewage [21, 22]. The water resource safety in scenic spots will also be influenced by the water required for ecology and the environment.

When the comprehensive factors influencing water resource security are analyzed, the factors influencing water resource security in scenic spots should be analyzed from the perspective of influence degrees on water yield and water quality. For selecting typical years, we should take the special years with apparent fluctuation of rainfall or number of tourists as the object. According to the above analysis, the key factors influencing water resource security in the scenic spot include the number of tourists, but the rainfall is not included. The more the tourists visit, the more the catering and accommodation water supply in the scenic area. The tourists' awareness of water conservation and environmental protection will positively and negatively affect the water yield and quality. Therefore, the number of tourists is the key factor influencing tourism water resource security in theory and practice.

2.3. Security Measurement and Pressure Analysis for Water Resource in Tourist Attractions. It is helpful to understand the water footprint of the tourism area by revealing the operation process of the water resource system. We can construct a tourism water footprint measurement model more comprehensively. The "water resource-social economy-ecological environment" is a complex cycle system. The security of the water resource system is the premise and guarantee for the healthy development of the social economy and the stability of the ecological environment. The security of the water resources system in the tourism area refers to the balance between the supply of water resources and the demand for water resources account. The water resources account of the tourism area mainly involves the water such as accommodation, entertainment, ecological environment, catering and drinking water, and the virtual water consumed by food and transportation fuel. The virtual water needed for transportation and catering in tourism activities is provided outside the region. That is to say, the water resources supply of tourism area is divided into internal and external regions. For some water shortage tourist areas [23], the water resource can only provide part of the real water demand for normal tourism activities. Using virtual water outside the region to ensure the normal development of various activities in tourism has become the key to the sustainable development of tourism in these areas. The virtual water provided outside the region has become one of the important guarantees for the security of the regional water resource system. Therefore, it is necessary to introduce the concept of virtual water into the safe operation of the water resource system. Tourism activities exert pressure on the water resource system and rely on water resources outside the region. The coordinated water supply within and outside the region can maintain the safe operation of the system and promote the healthy development of tourism.

Water footprint represents the amount of real water resources needed to maintain the consumption of human products and services, so it can comprehensively measure real and virtual water use.

In the consumption of human water footprint, domestic water usually accounts for a small part. Most of them are expressed in the form of virtual water. Virtual water consumption is the most important part of the water footprint. Similarly, normal tourism activities are also inseparable from the support of water resources. The water footprint refers to the amount of water resources needed to maintain the smooth progress of tourism. Gosling pointed out that the water footprint of tourist areas includes the real water directly used for accommodation and entertainment facilities [24, 25] and the virtual water implied in catering and transportation. Its conceptual model is shown in the following equation:

$$\mathrm{WF} = \begin{cases} (\mathrm{AWF} + \mathrm{ACWF}) + (\mathrm{DWF} + \mathrm{FWF}), \\ \mathrm{directWF} + \mathrm{indirectWF}. \end{cases} \tag{8}$$

In equation (8), WF represents the total water footprint in the scenic spot; AWF represents the water footprint of accommodation in the scenic spot; ACWF represents the water footprint of recreational activities in the scenic spot; DWF represents the water footprint of catering service in the scenic spot; FWF represents the water footprint of fuel consumed by the traffic in the scenic spot.

Gosling's water footprint conceptual model analyzes the direct and indirect water consumption for tourism activities from the accommodation, entertainment, catering, and transportation. However, it still stays on the conceptual model and does not put forward the specific water footprint measurement formula in the operational sense. From the perspective of sustainable development, protecting the ecological environment is fundamental to tourism development. Maintaining the amount of water resources is significant for maintaining the healthy development of the ecological environment of tourist areas. Therefore, the water consumption of the ecological environment should be included in the water footprint. Gosling's conceptual model of water footprint is modified based on real water and virtual water. The submodel of ecological environment water is supplemented, and then the operable measurement formula of the submodel is established to comprehensively measure the total water resources required by the tourism areas to maintain tourism activities and sustainable development. The water footprint of accommodation includes the daily water consumption of tourists, permanent residents, and employees. This part of water consumption is visible. It is mainly used for drinking, brushing teeth, washing, bathing, and flushing the toilet. Different hotels have different standards for water use. Therefore, the water consumption of accommodation is the sum of water demands of the main bodies is the actual water consumption. The number of water types.The accommodation water footprint model is shown in the following equation:

$$\mathrm{AWF} = \sum_{i=1}^{n} Q_i N_i. \tag{9}$$

The catering water footprint consists of virtual water and real water. One part is the water contained in the food consumed by tourists, permanent residents, and employees (including agricultural products and animal products), which is mainly the virtual water. The virtual water content of crop products is the total water demand for producing the crop. The virtual water content of animal products is the sum of the water consumed for the production and processing of feed, drinking water of animals, cleaning water, slaughtering, and processing water. The other part is the daily drinking water for tourists, permanent residents, and employees, mainly real water. In order to overcome the difficulties in obtaining the food consumption structure and consumption data of tourists, we can assume that the amount of food consumed by tourists in a tourist area is the same as that of residents. In general, the amount of healthy drinking water for people is not less than 2000 ml. This standard is used to calculate the daily drinking water for tourists, permanent residents, and employees. The model for calculating the catering water footprint of the tourist area is shown in the following equation:

$$\mathrm{DWF}=\sum_{i=1}^{m}N_iD_i\left(\sum_{j=1}^{n}C_jV_j+0.002\right), \tag{10}$$

where N_i is the number of virtual water resources. D_i is the virtual water consumption per unit. C_j is the number of real water types. V_j is the real water consumption per unit.

The traffic water footprint refers to the amount of water contained in the fuel consumed by tourists when they arrive at the scenic spot from the origin of the trip and travel in the scenic area, and it is mainly the virtual water. Transportation energy consumption is the product of the tourist's "travel distance" and the energy consumption per unit distance of various forms of transportation selected by tourists. The fuel is extracted from petroleum. For the convenience of calculation, the virtual water content per unit of energy consumed by transports can adopt crude oil's unit virtual water content standard. The model for calculating traffic water footprint is shown in the following equation:

$$\mathrm{FWF}=1.06\sum_{i=1}^{n}N_iD_iC_i, \tag{11}$$

where N_i is the number of water use bodies. D_i is the distance. C_i is the energy consumption per unit distance.

The water footprint of recreational activities in a tourist area refers to the water resource required for some recreational activities or landscapes, such as golf, skiing, swimming, and Waterscape Park. This kind of water consumption is mainly physical water, which should be the sum of water required for various recreational activities or landscapes. Q_i is the water required for each activity. N_i is the number of water users. The water footprint model of recreational activities in tourist areas is shown in the following equation:

$$\mathrm{ACWF}=\sum_{i=1}^{n}Q_iN_i. \tag{12}$$

The water required for ecology and the environment refers to the total amount of water resources to maintain the normal growth of organisms and the healthy development of the environment. According to the eco-environmental function of the ecosystem, the eco-environmental water demand can be divided into four aspects:

(i) Water demand of river ecological environment.

(ii) Ecological water demand for vegetation.

(iii) Water demand for lake wetland protection and restoration of ecological environment.

(iv) Water demand for urban ecological environment.

The water required for ecology and the environment includes river supplements, vegetation conservation, and other types of ecological water storage. Still, this part of the water is often directly converted by rainfall, so it is not easy to adjust or use it manually. Therefore, the ecological environment water footprint does not include this part of ecological water storage. It only refers to the water that is really consumed and utilized. The eco-environmental water consumption in tourist areas mainly consists of the water required for greening, environmental sanitation, and fire protection. According to the actual water consumption in the ecological environment of tourist destination, Q_i is the consumption of water, and A_i is the type of water demand. The water footprint model of the ecological environment is shown in the following equation:

$$\mathrm{EWF}=\sum_{i=1}^{n}Q_iA_i. \tag{13}$$

The total water footprint of the tourism area is the sum of calculation results of five submodels represented by TWF, and TWF is given by the following equation:

$$\mathrm{TWF}=\mathrm{AWF}+\mathrm{DWF}+\mathrm{FWF}+\mathrm{ACWF}+\mathrm{EWF}. \tag{14}$$

Some experts researched the water ecological carrying capacity and the water supply and demand in tourist attractions. This paper comprehensively measured real and virtual water content and the distribution among ecological elements based on the water footprint model. This is conducive to quantitative measurement of water resource security and timely adjustment of water allocation in scenic spots. According to its unique tourism resource and its characteristic of tourism development, the scenic spot mainly focuses on natural tourism. Therefore, the water footprint calculation is not included in the subfootprint of recreational activities. Equation (14) is adjusted as shown in the following equation:

$$\mathrm{TWF}=\mathrm{AWF}+\mathrm{DWF}+\mathrm{FWF}+\mathrm{EWF}. \tag{15}$$

The results of water footprint measurement can provide a basis for the quantitative calculation of water resource pressure. Based on the water footprint theory, the water resource pressure index is used to measure the ecological environment pressure degree. The formula to calculate the water footprint measurement is shown in the following equation:

$$\mathrm{WP}=\frac{\mathrm{WF}}{\mathrm{WA}}. \tag{16}$$

2.4. Ecological Compensation System of Water Resources. For many years, the construction and protection of the ecological environment in scenic spots has improved the local ecological environment, ensured good water quality, ensured the clean water resource in downstream water-receiving areas, and provided beneficial ecological services for water supply and the water-receiving regions. The government and people in water source areas have invested a lot of human, material, and financial resources to protect and treat the ecological environment. Due to the poor economy of some scenic spots, the economic and social development of the water source area is hindered, and the local poverty is intensified. It is difficult for people to bear the heavy responsibility of independently protecting the ecological environment. The contradiction between ecological environment protection and economic development in the water source area is increasingly prominent. In order to solve the contradiction of scenic spots, it is necessary to establish a feasible ecological compensation system to ensure the fair distribution of benefits in the water protection area and the water use area and promote the sustainable environmental protection and construction of water resources in tourist attractions. The existing laws and regulations have not made detailed provisions on the content of ecological compensation, so there is no legal basis for implementing the ecological compensation system. If the central government does not have perfect laws and regulations, it will be difficult for local governments to make breakthroughs. It is not easy to implement the cross-basin ecological compensation system without the coordination of the central government. Therefore, the ecological compensation must follow the relevant laws and regulations.

An effective ecological legislation mode is devised by taking the ecological compensation law as the basic law, cooperating with other laws and regulations, and establishing coordinated ecological compensation standards. The reason is that ecological compensation involves many fields, and it has complex characteristics. The economic development level, people's living standards, and ecological environment conditions in different regions are different. It is impossible to formulate a special ecological compensation law to adapt to all ecological compensation cases. In addition, some legal systems are often principle regulations with poor operability. Therefore, it is necessary to formulate special regulations to specify operable contents. Combining the basic law with the separate law and combining the principle provisions with the specific provisions can establish an ideal and feasible legislative model.

The core of the ecological compensation system is to determine the ecological compensation standard. The ecological compensation standard is directly related to compensators' affordability and compensation effect. Scientific and feasible ecological compensation standards are conducive to easing the contradiction between the ecological environment protection and the economic and social development in the water source area and promoting the coordinated and sustainable development of the ecological, economic and social environment.

Based on the above analysis results, the ecological compensation system of water environment resources in tourist attractions is built. The ecological compensation system mainly includes the following compensation methods:

(1) Increase policy compensation.

Policy compensation refers to the power and opportunity compensation of central government to provincial government and provincial government to municipal government. The compensation recipient can increase the support and preferential treatment of the basin within the scope of its power and form the aspects of industrial development, investment projects, finance, and taxation to provide policy support for raising ecological compensation funds. The less developed areas should fully use ecological protection policies and systems to get more compensation and implement ecological protection. The policy compensation of the water source protection area mainly includes targeted policy, market compensation policy, technical project compensation policy, and offsite development policy. The ecological compensation mechanism of tourist attractions is a complex transprovincial project, and the central government and local governments should attach great importance to it and increase policy support.

(2) Increase capital compensation investment.

The fund compensation means that the central government or provincial government and water beneficiaries provide funds to govern and restore the ecological environment of water protection areas. Financial compensation is the most common and most urgent way of compensation, so it should become the main way of ecological compensation. The fund compensation can be applied to various types of ecological compensation mechanisms. At present, there is still a large funding gap in the ecological compensation of tourist attractions, so it is challenging to meet the needs of protecting and constructing the ecological environment. Therefore, the shortage of funds has always been the bottleneck of ecological construction and protection of tourist attractions. In addition, the adjustment of the ecological industry needs high-tech investment, new rural construction, and ecological migration needs a lot of financial support. In addition, the main force of ecological compensation is farmers. Only when their income is fully guaranteed can the sustainability of ecological protection and construction be maintained, and the ecological environment of the source area will be protected for a long time.

(3) Provide additional compensation for talent training.

Ecological protection and construction of water source protection areas need a group of high-quality professionals. The government should organize and provide free technical guidance and consulting services, export management theories and professional knowledge, cultivate and transport management and technical personnel in the local area, and thus improve the production skills and management level of the compensated groups.

(4) Promote project and industrial compensation.

At present, the ecological environment protection of water protection areas in China also involves the natural forest protection, wild animals and plants protection project, and project to return the grain plots to forestry. Increasing the ecological compensation for these projects can better protect the ecological environment. In addition, the best way to improve people's living standards is to develop and strengthen the characteristic industry and promote its hematopoietic function. The government can provide preferential policies and build an industrial

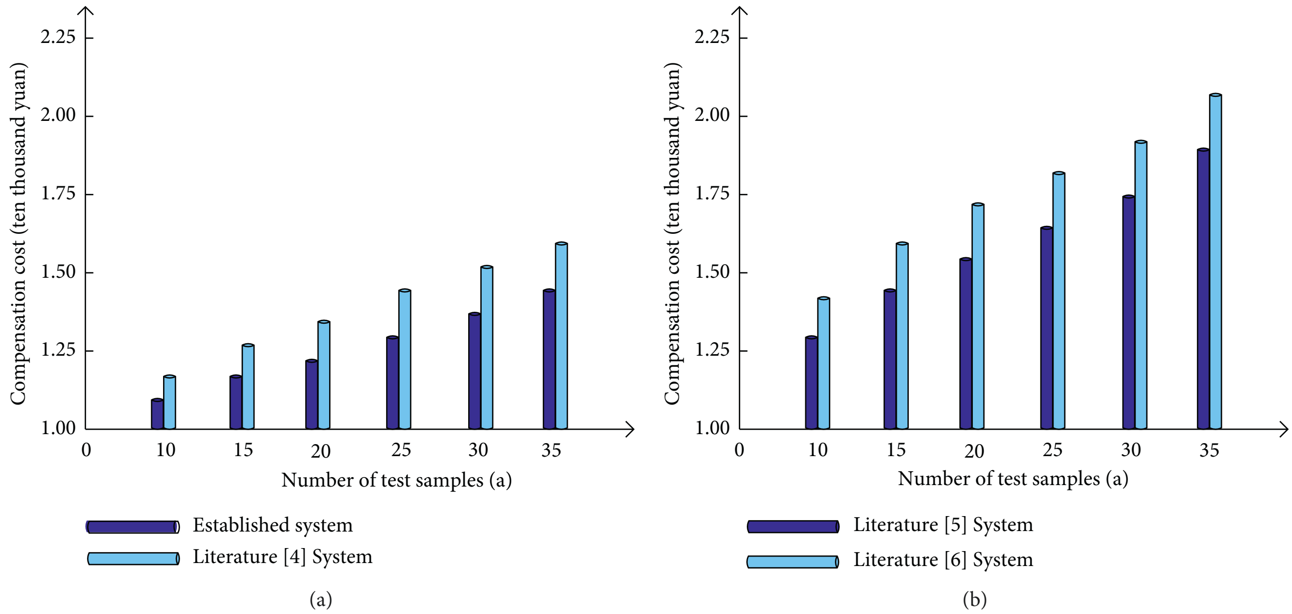

Figure 1: Comparison of compensation costs of different compensation systems.

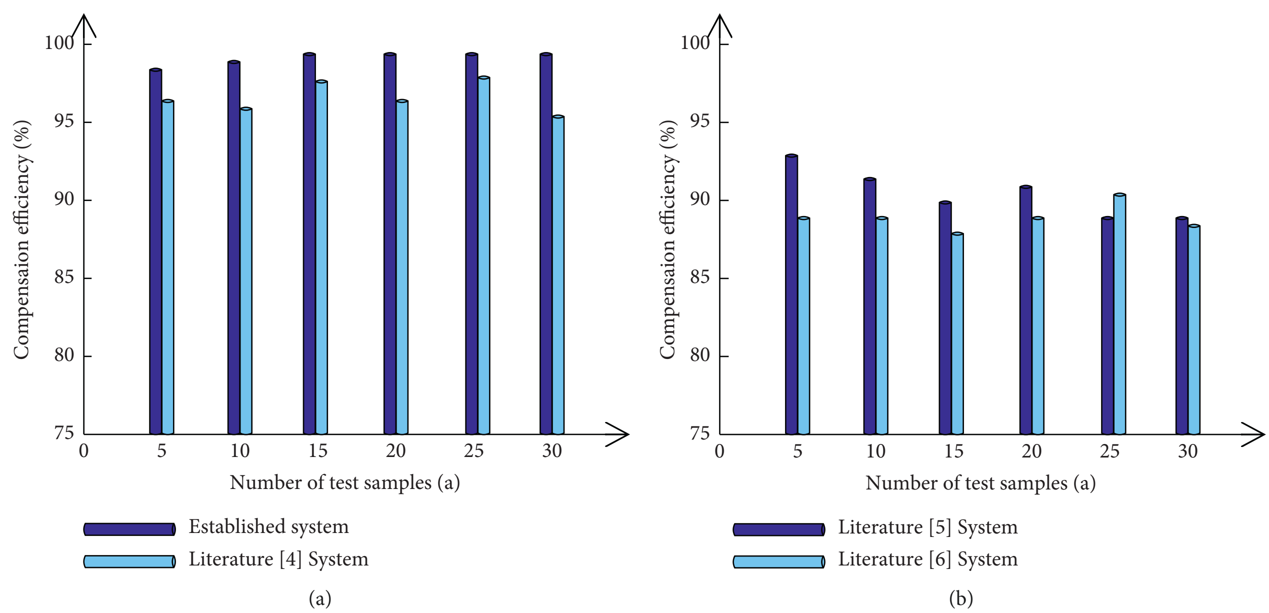

Figure 2: Comparison of compensation efficiencies of different compensation systems.

platform for the ecological industry of water protection areas, thus promoting the development of local industries.

3. Simulation-Based Experimental Study

In order to verify the comprehensive effectiveness of the designed ecological compensation system, it is necessary to perform the simulation test. The experimental environment is Windows 10×64 system. The computer configuration is Intel (R) Corei5-8400. The main frequency is 2.8 GHz, and the memory is 16 GB.

3.1. Compensation Cost (10000 Yuan). Three kinds of compensation systems were selected as the comparison objects in the experiment. The systems in [4, 6] were compared with the designed system, and the compensation costs of different systems were compared. The comparison results are shown in Figure 1.

After analyzing the experimental data in Figure 1, we can see that the compensation cost of the designed compensation system is lower so that the problem of the extent of ecological damage to water environment resources is effectively solved, and the corresponding compensation scheme can be given. In addition, the waste of human and material resources can be effectively avoided, and the compensation cost will also decrease.

3.2. Compensation Efficiency (%). The speed with which ecological compensation systems in public attractions places compensate has always been a contentious issue. Proposed Simulation experiments are conducted to compare the compensation efficiency of different systems, and the experimental results are shown in Figure 2.

According to the experimental data in Figure 2, the compensation efficiency of the whole system has been dramatically improved because the problem of the extent of ecological damage to water environment resources was effectively solved. The compensation efficiency of the designed system is significantly higher than that of other compensation systems.

4. Conclusions

The ecological compensation system is a new management mode of resource and environment. It is also an important content of the innovation of ecological and environmental protection policies in the new era. Establishing an ecological compensation mechanism in the water source protection area can ensure the safety of the water source and promote the sustainable and coordinated development of the economy and environment of the whole basin. The ecological compensation is still in the primary stages, so many problems are inevitable in the practice process. To improve the ecological compensation system, based on improved grey relational analysis, the ecological compensation system for water resources for public areas is proposed in this paper. The proposed method will improve the relevant laws and regulations, clarify the main body of ecological compensation, establish the standard of ecological compensation, optimize the mode of ecological compensation, implement diversified ecological compensation, and establish the reward and punishment mechanism of the ecological compensation system. The proposed method also improves the assessment and supervision mechanism of ecological compensation. Simulation results show that the proposed method can effectively improve compensation efficiency and reduce costs. Due to the limited time and medium, the designed compensation system's empirical data and quantitative analysis are not enough. In future work, the compensation system needs to be further expanded and improved by considering more environmental factors.

Data Availability

All the data pertaining to this paper are included within the paper.

Conflicts of Interest

The author declares that there are no conflicts of interest regarding the publication of this paper.

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