Study on Ecological Compensation Mechanism of Railway Construction Projects

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Abstract. Important ecologically sensitive areas are extremely important to maintain regional ecological security. For railway construction projects that cross important ecologically sensitive areas, it is particularly necessary to implement ecological compensation in order to minimize the impact on important ecologically sensitive areas. This article introduces the ecological service function value loss accounting and ecological value loss accounting methods from the perspective of value, and puts forward the system introduction method, technology introduction method and compensation method introduction method of ecological compensation, combining the environmental impact assessment system and ecological compensation mechanism in order to improve the feasibility and operability of ecological compensation.

1 Introduction

Railway is one of the important transportation infrastructures. The construction of railway projects will greatly promote the regional social and economic development, and at the same time, it will inevitably occupy a large amount of land, bringing environmental pollution and ecological damage^[1]. Among the ecological impacts brought by railway construction, the impacts on important ecologically sensitive areas are the most important. Rare and endangered wild animals and plants or important ecological service functions are preserved in important ecologically sensitive areas, which is extremely important to maintain China's ecological security. Generally speaking, railway construction projects will try to avoid important ecologically sensitive areas during the route selection stage. However, due to political, transportation needs, and transportation volume factors, many railway construction projects inevitably cross important ecologically sensitive areas. It has caused damage to rare and endangered animals and plants, and important ecosystems. How to adjust the relationship between the protection of important ecologically sensitive areas and railway construction, and establish an ecological compensation mechanism is one of the solutions.

2 Research on Ecological Compensation Standards for Railway Construction Projects

2.1 Ecological compensation accounting method

Ecological compensation generally includes three aspects: one is to compensate the cost of restoration or destruction of important ecosystems; the other is to compensate the cost of protection (recovery) or destruction of individual or regional protected ecosystems; third type is to make protective investments in areas or objects with important ecological value^[2]. For railway construction projects that cross important ecologically sensitive areas, this is the corresponding third type.

There are two methods for determining the ecological compensation standard, one is the accounting method and the other is the negotiation method. The accounting method is a standard method for determining ecological compensation based on the evaluation of ecological environment loss or the value of ecological service functions. According to the characteristics of railway projects, the impact of railway construction projects on the ecological environment is generally reflected as the impact on ecological factors and the impact on ecosystem service functions. In terms of ecological compensation accounting, it can be summarized as ecological service function value loss accounting and ecological value loss accounting (shown in Figure 1), its functional relationship can be expressed as:

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Figure 1. Framework Chart for the Standard Accounting of Ecological Compensation.

$$F = k_1 \sum_{i=1}^4 B_i + k_2 \sum_{i=1}^n D_i$$

F —Compensation value of ecological environment loss;

B_i —Compensation value for loss of type i ecological services (water conservation, soil and water conservation, wind and sand fixation, and biodiversity);

D_i —Compensation value of the i -th ecological factor loss (animal, plant, soil and other ecological factors);

k_1, k_2 —Coefficient;

n —Number of ecological factors;

The negotiation method is a method for the stakeholders to determine the standard of ecological compensation through a certain range of ecological compensation. In specific practice, ecological compensation standards should often be based on nuclear algorithms and agreed through negotiation.

2.2 Accounting for Loss of Ecological Service Function Value

Ecological service value accounting is the monetization evaluation of the service functions provided by the ecosystem, mainly including the value calculation of water conservation, water and soil conservation, wind and sand fixation, and biodiversity.

Ecological service function value accounting methods can be divided into two categories: one is alternative market technologies, which use "shadow prices" and consumer surplus to express the economic value of ecological service functions. There are various evaluation methods, including market value method, cost method and replacement cost method, disease cost method and

human capital method, opportunity cost method, travel cost method, and hedonic price method. The second is simulated market technology (also known as hypothetical market technology), which uses willingness to pay and net willingness to pay. There is only one evaluation method for expressing the economic value of ecological service functions, namely the conditional value method [3]-[8]. There are many accounting methods for the loss of ecological service function value. You can choose an appropriate accounting method for the specific railway project characteristics and ecosystem characteristics.

2.3 Accounting for Loss of Ecological Value

The impact of railway construction projects on ecological factors is not only manifested in the impact on biological factors such as animals and plants, but also in the impact on abiotic factors such as soil and terrain. Important ecological sensitive areas generally have important ecological service functions or important protected species. For the sections crossing important ecologically sensitive areas, accounting for the loss of ecological value of important protected species is particularly necessary. In order to improve the operability of the accounting, plant factors and animal factors are selected for accounting. The functional relationship of ecological value loss accounting is as follows:

$$D = \sum_{i=1}^n k_i D_i$$

Accounting method for loss of plant factor as follows:

$$D_1 = P_i r$$

D_1 —Compensation value for plant loss;

P_i —Cost of transplant per plant;

r —Numbers of plants.

Accounting method for loss of animal factor as follows:

$$D_2 = n_{i1}p_i + n_{i2} \sum_j^s Q_{ij}A_{ij}P_{ij}$$

D_2 — Compensation value for animal loss;

n_{i1} — Number of direct deaths of species i ;

n_{i2} — The number of species of animal life lost, $n_i = n_{i1} + n_{i2}$, n_i is the i -th species affected by railway construction;

Q_{ij} — Degree of loss of life at level j of animal i ;

A_{ij} — Possibility of loss of life at level j of animal i ;

P_{ij} — Price of animal i ;

j — The degree of animal life loss, s is the number of levels.

3 Introduction Route Analysis

3.1 System Introduction Method

At present, China's ecological compensation mechanism still lacks a unified and sound management mechanism^[9], and railway construction projects also lack the practice and management policy of ecological compensation. Environmental impact assessment, as one of China's important environmental protection systems, has mandatory legal effects. Integrating ecological compensation into environmental impact assessment can make up for the current situation of incomplete ecological compensation legal system, incomplete policies, and difficult implementation of ecological compensation. It can improve the feasibility and operability of the implementation of ecological compensation.

3.2 Technology Introduction Method

The environmental impact assessment has a complete technical guideline system, with mature environmental impact identification, environmental status investigation, and environmental impact prediction analysis methods. Ecological compensation can include the content of ecological compensation under the framework of the environmental impact assessment technology system. For example, through the identification of environmental impacts, the scope of ecological compensation is determined; through the investigation of the status quo of the environment, the damage recipients are determined, and the subject and object of ecological compensation are determined; through the analysis of environmental impact prediction, the standard of ecological compensation is determined; to determine the method of ecological compensation by proposing environmental protection countermeasures.

The introduction of ecological compensation into environmental impact assessment can make ecological

compensation work form a unified management mode and management system. In the environmental impact assessment of construction projects, the scope, object, standard and method of ecological compensation are determined through the identification, prediction and evaluation of the environmental impact of the construction project, and the scope, object, standard and method of ecological compensation are determined through environmental impact approval, and as the basis for the implementation of ecological compensation. Through environmental supervision during the construction period, the implementation of ecological compensation is supervised, and the effect of ecological compensation is tested through the acceptance of environmental protection in the completion. Through the post-environmental impact evaluation, it reviews the effect of ecological compensation, analyzes the original compensation subject, object, standard, method, scope and other experience and problems, and puts forward improvement measures or further compensation requirements.

3.3 Compensation Introduction Method

According to the characteristics of railway construction projects, the best compensation method is monetary compensation, which is included in project investment. During the feasibility study phase, the environmental impact assessment and environmental protection design are carried out simultaneously, and the standard of ecological compensation is determined through environmental impact assessment. The completion of ecological compensation investment is included in the project investment estimate in environmental protection design. Before the initial design, construction drawings, and implementation of ecological compensation, the scope, objects, and standards of ecological compensation should be verified, and ecological compensation should be adjusted and implemented according to actual conditions.

4 Conclusion

For railway construction projects that cross ecologically sensitive areas, ecological compensation is a means to achieve a balance between railway construction and environmental protection. The mature environmental impact assessment system provides a platform for the implementation of ecological compensation, which can improve the feasibility and operability of ecological compensation. In addition, the article mainly introduces the compensation value methods of two ecological factors of animals and plants, but there is still no mature method for quantitatively estimating the compensation value and defining the ecological loss for the value of ecosystem service functions and the compensation value of other ecological factors. The target index system of the ecological compensation of the construction project and the target index system of the quantified index layer need further study.

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