

# Research on Ecological Compensation Index System Based on Value Realization of Ecological Products

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**Abstract:** The realization of the value of ecological products is a hot topic in the field of environmental accounting in recent years. With the continuous advancement of human economic activities, it has a series of impacts on the ecological environment, so it is necessary to conduct research on ecological compensation. Based on the perspective of realizing the value of ecological products, this paper constructs an ecological compensation index system through AHP model, and uses DPSR model to analyze the operating mechanism between economic activities and ecological environment. Finally, the following conclusions are reached: (1) Human economic activities and ecological environment jointly build an ecological economic system, which presents the operation mechanism of "D (Driving force) -P (Pressure) -S (State) -R (Response)". Human activities generate system driving force and environmental pressure, and when the carrying capacity of the system state is exceeded, human will produce environmental protection and other response behaviors. (2) Because human economic activities need to make ecological compensation to the ecological economic system. Through the value realization mechanism of ecological products, the efficiency of ecological compensation can be improved, and it is conducive to the efficient and coordinated operation of the ecological economic system.

**Keywords:** Ecological products, Value realization, Ecological compensation, Dynamic mechanism, DPSR model.

## 1. Introduction

Ecological products are a new concept proposed in the field of environmental accounting in recent years. A small number of scholars at home and abroad have published related research on it. It is generally expressed as Eco-label products. The two are very similar in definition, composition, policy support and application context.

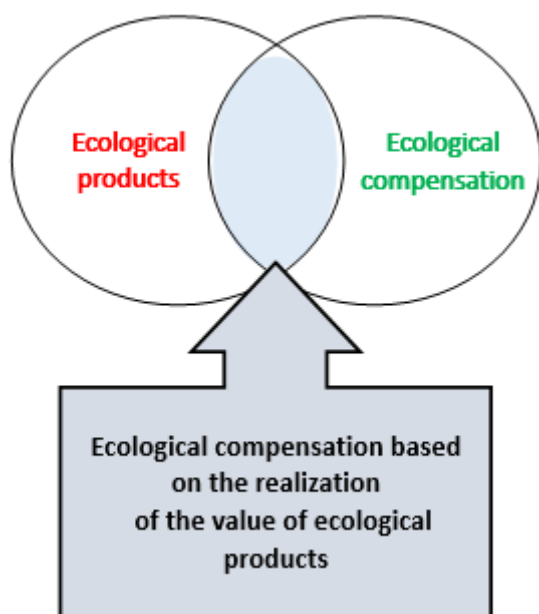


Figure 1. Conceptual Relationship Diagram

For the research on the value realization of ecological products, the academic circle focuses on two aspects at present. One is the research on the path of the value

realization of ecological products, including ecological protection compensation, ecological ownership transaction, economic development and utilization, green financial support and other measures; The second is to study the mechanism of realizing the value of ecological products, including improving the compensation mechanism, price mechanism, financial mechanism and accounting mechanism of realizing the value of ecological products from the perspectives of fiscal revenue, market system, ecological property mortgage loan and the improvement of basic standard system.

Ecological-economic systems can not only provide rich ecological products for people, but also play an important role in maintaining the ecological balance of the earth. However, long-term extensive development has threatened regional ecological security, and human beings have begun to develop and use natural resources endlessly. Facing this problem, the academic community put forward the concept of ecological compensation. Ecological compensation mainly solves the externality problems generated in the process of consumption and supply of public goods. Therefore, based on the concept of value realization of ecological products, this paper studies the operation mechanism of ecological economic system and the performance index system of ecological compensation, with the purpose of providing theoretical support for the performance evaluation of ecological compensation and expanding the research scope of environmental accounting to a certain extent.

## 2. Literature Review

### 2.1. Related research on value realization of ecological products

Scholars point out that the realization of the value of

ecological products requires the government and the market to play an important role in turning external ecological resources into internal ecological assets. Based on this, Qiu Shuolin (2021) pointed out that the role of the government in the realization of ecological product value should be the cultivation of the main body of the ecological product market, the implementation of the definition of natural resource property rights and the placement of the ecological product market. The boundary of government behavior should be limited to not interfering in the operation and decision-making power of market subjects, not infraining the property rights of natural resources and not destroying the market-oriented transaction mechanism. In addition, Jin and Lu (2021) believed that the four aspects of theory construction, investigation and evaluation, value accounting and realization path need to be further explored. It is proposed that the value realization analysis system with multi-disciplinary integration, diversified data basis and diversified technology support should be constructed in the future research. Yu Huiyi (2020) studied the practical experience at home and abroad, and found that to realize the value of ecological products, it is necessary to fully rely on the industrialization of ecological resources, identify their own positioning to promote the ecological industry, and establish a market-oriented public compensation mechanism for ecological products under the leadership of the government. In addition, we should give full play to people's subjective initiative and integrate market mechanism into the process of value realization.

## **2.2. Related research on performance evaluation of ecological compensation**

Ecological compensation policies only began to be implemented in large numbers in the 1990s, while performance evaluations took off in the early 2000s. Earlier performance evaluations abroad were mostly concentrated in regions that took the lead in implementing ecological compensation policies, such as the United Kingdom, Costa Rica, and Mexico. Since ecological compensation is mostly implemented in areas with weak development, scholars will pay additional attention to the situation of local farmers in addition to the effects of ecological compensation policies. Pagiola explored the possible influencing factors of ecological compensation on poor households, and believed that it mainly included the degree of poverty, the ability to participate in the project, and the amount that the project could pay. Zilberman compared the impact of two ecological compensation models on farmers and found that converting farmland to environmentally friendly land was more beneficial to farmers' incomes than converting farmland to other land. Deng Yuanjian and Xiao Rui (2015) explored the performance evaluation of ecological compensation policies for the environment of green agricultural producing areas, and pointed out that the utilization efficiency of ecological capital of the environment of green agricultural producing areas should be determined. Yu Huiyi and Xu Zhihua (2016) researched the ecological compensation performance and its influencing factors.

## **2.3. Review**

In terms of value realization of ecological products, domestic scholars have conducted multi-level discussions on the concept and classification of ecological products, such as public ecological products represented by forests, and carried out value realization mode exploration and application research based on different types of ecological products. In addition, the literature points out that the main path to realize the value of ecological products is the compensation mechanism for ecological protection, which reflects the necessity of exploring the compensation mechanism for ecological products. The related research on ecological compensation mechanism is mainly in two fields, which are pre-compensation research and post-compensation research respectively. The research before compensation is generally based on theoretical exploration; Post-compensation research focuses on effect evaluation and case analysis. There are more research results and perfect system at home and abroad, but the performance evaluation of ecological compensation in our country is still in its infancy and faces many difficulties. Therefore, this paper chooses forest, a representative ecological product, as the entry point, and explores issues related to ecological compensation based on the realization of its ecological product value.

## **3. Methods and Materials**

In this paper, AHP model is adopted to construct ecological compensation performance index system based on the perspective of ecological product value realization.

### **3.1. Structure the Hierarchy**

When using AHP to solve specific problems, we should first clarify the type of problem to be solved, and have a clear problem on the various indicators involved in the problem and the relationship between indicators. On this basis, the problem is divided into three specific levels: the first layer is used to clarify the main goal of the problem to be solved, which is called the goal layer; The second layer is used to refine the solution of the problem, is the refinement of the target layer, called the criterion layer; The third layer is the most basic element index of the index system, which is called the index layer.

### **3.2. Constructing the judgment matrix**

After establishing the hierarchical structure model of AHP, it is necessary to judge the weight status of indicators at each level, and the concept of judgment matrix should be introduced here. The judgment matrix is to judge the relative importance of each related index in this level for a certain index at the previous level. The judgment matrix is a process in which people's conceptual views on the relative importance (or advantages and disadvantages, preference, intensity, etc.) of the components of an index are transformed into concrete numbers. The corresponding matrix element values are generally measured in the way of 1/9-9. The specific judgment matrix scaling values and their corresponding meanings are shown in Table 1:

**Table 1.** Meaning of judgment matrix scale

Value of scale	meaning
1	Indicates that factor i is of equal importance to factor j
3	Factor i is slightly more important than j
5	Factor i is significantly more important than j
7	Factor i is strongly more important than j
9	Factor i is extremely important compared with j
2, 4, 6, 8	Need to add a compromise index between factors i and j
multiplicative inverse	The ratio of importance of factor i to factor j is 1/a

### 3.3. Hierarchical sort

After the establishment of the judgment matrix, it is necessary to determine the importance of its specific weights, that is, to carry out hierarchical sorting, including hierarchical

single sorting and hierarchical total sorting. In the process of hierarchical single sorting, it is the process of solving the eigenroots and eigenvectors corresponding to the judgment matrix.

**Table 2.** Hierarchical total sort

Level A	A1	A2	...	Am	The total sort of level B
Level B	a1	a2	...	am	
B1	b11	b12	...	b1m	$\sum_{j=1}^m a_j b_{1j}$
B2	b21	b22	...	b2m	$\sum_{j=1}^m a_j b_{2j}$
...	...	...	...	...	...
Bn	bn1	bn2	...	b1m	$\sum_{j=1}^m a_j b_{nj}$

Obviously there is  $\sum_{i=1}^n \sum_{j=1}^m a_j b_{ij} = 1$ , the total rank of the

hierarchy is the normalized normal vector.

Assuming that there is A judgment matrix A,  $\lambda_{\max}$  is the largest characteristic root of the judgment matrix A, and  $\lambda_{\max}$  satisfies  $AW = \lambda_{\max}W$ , then W is the normalized characteristic vector corresponding to  $\lambda_{\max}$ , and it can be seen that  $W_i$  is the actual weight value obtained by the corresponding hierarchical single sorting. The consistency test of the corresponding judgment matrix must be carried out when the corresponding weight is obtained through hierarchical single sorting. The consistency test index CI is introduced here, and its expression is  $CI = \frac{\lambda_{\max} - n}{n - 1}$ . From

this formula, it is defined that when  $CI=0$ , the judgment matrix A has complete consistency; Moreover, it can be seen that the greater the specific value of CI is, the worse the consistency of the corresponding judgment matrix A is.

The process of determining the importance weight of each element of the total goal of the hierarchy is called the total ranking of the hierarchy, and the corresponding calculation order is carried out in descending order from high to low. Suppose that level A is the superior level, A1, A2... , Am The m indicators of each specific element in the level, the corresponding total ranking weight of the level is a1, a2,... am, B is the next level of A, B1, B2... , Bn, the n indicators are the specific elements in the level, and the corresponding total ranking weights of the level are b1j, b2j... , bnj (where, if  $b_{ij}=0$ , it means that Bi has nothing to do with Aj).

### 3.4. Test Result Consistency

After the total hierarchical ranking is completed,

consistency test needs to be carried out, and the specific index calculation process is as follows:

$$CI = \sum_{j=1}^m a_j CI_j \quad (1)$$

In Formula (1), CI index represents the consistency of the total hierarchical ranking, and  $CI_j$  index represents the consistency of the judgment matrix of level B (the corresponding level of  $a_j$ );

$$RI = \sum_{j=1}^m a_j RI_j \quad (2)$$

In Formula (2), RI index represents the random consistency of the total hierarchical ranking, and  $RI_j$  index represents the random consistency of the judgment matrix at level B (the corresponding level of  $a_j$ );

$$CR = \frac{CI}{RI} \quad (3)$$

In Formula (3), CR represents the proportion of random consistency and corresponding consistency of the total hierarchical ranking.

In the consistency test results of the total hierarchical ranking, if  $CR < 0.1$ , it means that the total hierarchical ranking has satisfactory consistency. On the contrary, if  $CR \geq 0.1$ , it indicates that the total hierarchical ranking does not have acceptable consistent calculation results and must be further adjusted to be satisfactory.

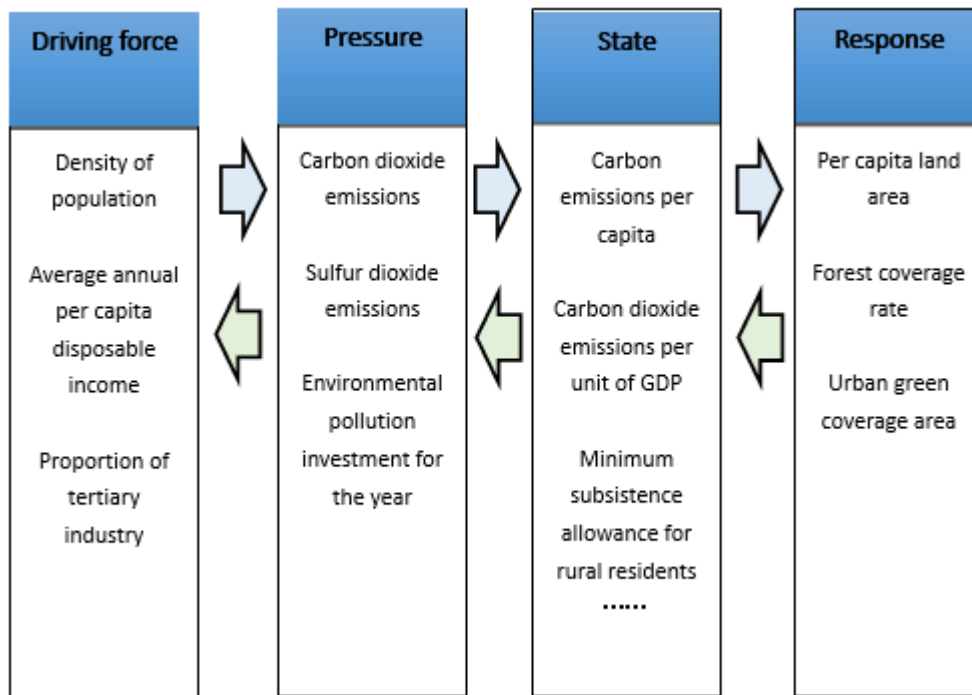
## 4. Results

Based on the DPSIR model framework and AHP hierarchical structure principle, the forest ecological compensation performance index system based on the

realization of ecological product value is constructed in this paper, including three levels: target layer, criterion layer and indicator layer, and 14 refined indicators. The specific index system is shown in Table 3.

**Table 3.** Ecological compensation performance index system based on the realization of ecological product value

Target level	Guideline level	Indicator layer
Ecological compensation system based on the realization of ecological product value	Driving force	Density of population
		Average annual per capita disposable income
		Proportion of tertiary industry
	Pressure	Carbon dioxide emissions
		Sulfur dioxide emissions
State	Environmental pollution investment for the year	
	Carbon emissions per capita	
	Carbon dioxide emissions per unit of GDP	
	Minimum subsistence allowance for rural residents	
Response	Number of employees participating in endowment insurance	
	Village hospitals and health workers	
	Per capita land area	
		Forest coverage rate
		Urban green coverage area



**Figure 2.** Operation mechanism of DPSIR in eco-economic system

The Driving force module includes population density, average annual per capita disposable income, and the proportion of the tertiary industry. Thus, due to a series of human activities, the ecological economic system is produced, and due to human natural activities and social and economic activities, the ecological economic system has a driving force for operation, and the whole system starts a complex operation mechanism.

In the Pressure module, it includes carbon dioxide emissions, sulfur dioxide emissions and investment in environmental pollution this year. The above three indicators respectively reflect the pressure of pollutant discharge, the pressure of pollutant discharge and the impact of human activities on the environment. In the process of the operation of the ecological economic system, human economic

behavior is based on the input-output principle, and a series of resources are invested to produce the products of economic activities. These ancillary products cause pressure on the operation of the eco-economic system, and the pressure module will be transmitted to the next state module of the system.

In the State module, there are five detailed indicators, namely, per capita carbon emissions, carbon dioxide emissions per unit GDP, the number of rural residents with minimum living security, the number of employees participating in endowment insurance, and rural hospitals and health workers. The indicators in these state modules are the concrete embodiment of the pressure module, that is, how the pressure is reflected in the operation process of the ecological economic system after it is generated. When the indicators in

some state modules exceed the carrying capacity, the ecological economic system will not operate normally, so the response module will be opened to realize the coordinated operation of the whole system again.

The Response module includes land area per capita, forest coverage rate and urban green coverage area, which all reflect the performance level of environmental protection policies. The response module is transmitted from the above driving

force module, pressure module and state module in the ecological economic system, specifically the response when the indicators in the state module exceed the carrying capacity. It shows that human beings need to promote the benign operation of ecological economic system through the protection and improvement of ecological environment, and realize the coordinated development of human activities and ecological environment.

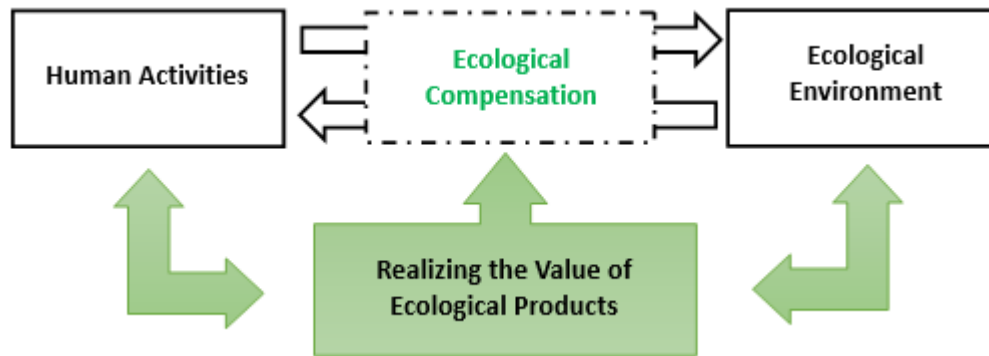


Figure 3. The value realization of ecological products helps ecological compensation logic diagram

## 5. Conclusions

The main conclusions of this paper are as follows:

(1) There is mutual influence between human economic activities and ecological environment, and the two jointly build an ecological economic system. Specifically, the operation of the ecological economic system presents a dynamic mechanism of "D-driving force -P pressure -S state -R response". Human activities drive the operation of the ecological economic system, and environmental pollution caused by economic activities generates pressure modules, which are reflected in a series of state modules in the ecological economic system. When the environmental carrying capacity is exceeded, Human beings will produce response behaviors such as environmental protection, which will restore the coordinated operation of the ecological and economic system.

(2) In the operation of the eco-economic system, due to a series of human economic activities and behaviors, it is necessary to make ecological compensation for the eco-economic system. Through the value realization mechanism of ecological products, the performance evaluation of ecological compensation can be effectively carried out, the efficiency of ecological compensation can be improved, and it is conducive to the efficient and coordinated operation of the ecological economic system.

In this paper, the use of AHP model is conducive to the accurate measurement of the ecological compensation performance evaluation system. Based on this model, the follow-up research will continue to use statistical data, questionnaire statistics and other methods to select typical representative research case areas to conduct quantitative research on the ecological compensation performance evaluation system in the operation of the ecological economic system.

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