Value Assessment Model of Ecosystem Services Based on PSR Model

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Abstract. In recent years, the rapid development of economy has led to some environmental degradation problems. Therefore, we need to seek better measures that include the value of ecosystem services (ESV) to fully reflect the multiple impacts of economic development. We combine the PSR model with the dynamic ecosystem service value evaluation model and propose rationalization suggestions for the planners and managers of the land development project.

1. Introduction
In the process of human transformation of nature, the planning of environmental costs has been widely valued. The most important subject of human activities is land, which plays a decisive role in the whole ecosystem. How much pressure we put on the environment largely depends on our use of land, and the environmental impact assessment of land use planning is to predict this pressure, strive to minimize the pressure, and find the most reasonable land development and utilization plan [1].

Then it has become the focus of current research to shift from economic growth to ecosystem services as the core of the sustainable development framework. Therefore, it is more urgent to build an ecosystem service evaluation model to measure the cost-benefit ratio of projects.

2. Overall Model
2.1. P-S-R Model
P-S-R (Pressure-State-Response) is an evaluation model commonly used in subdisciplines of ecosystem health assessment in the field of environmental quality assessment [2]. PSR model is based on causality, that is, human activities exert certain pressure on the ecological environment; Because of these pressures, the environment has changed its original nature or the state of natural resources; Humans also respond to these changes through environmental, economic and management strategies to restore environmental quality or prevent environmental degradation [3].

2.2. P-S-R Framework
Based on the analysis of the conditions given in the title, we summarize the changes in land development projects, ecosystem service values, and response decisions of relevant regulatory agencies into the PSR model.
3. Ecosystem Service Evaluation Model

3.1. Model Analysis
In order to more comprehensively determine and evaluate the cost-effectiveness and value of land-use development projects, we further develop based on traditional economic theories, consider the impact and changes of ecosystem services, and establish a comprehensive index system to measure the real economic cost of land-use projects.

3.2. Construction of Economic Cost Index System
After consulting relevant literature and combining with theoretical analysis, we built a three-level index system to measure the economic cost of land use project development. Among them, the target layer is the economic cost, and the ecosystem service value, resource consumption and environmental degradation cost are taken as the domain layer.

3.3. The Division of Economic Costs

3.3.1. Value of Ecosystem Service. Due to the specificity of the ecosystem it and the different evaluation methods have different evaluation criteria for the same ecosystem, we need to compare various evaluation methods and analyze from multiple perspectives from the perspective of the integrity of the ecological environment to select the best evaluation method. After consulting relevant references and understanding the advantages and disadvantages of various evaluation methods, we finally determined to use the equivalent factor method and binding emergy value conversion to evaluate ESV from multiple perspectives.

A) The Equivalent Factor Method Was Used to Evaluate ESV
Equivalent factor is based on the classification of ecosystem service functions into different categories. For different ecosystems, the value equivalent of various service functions is constructed based on quantifiable standards, and then the evaluation is carried out according to the distribution area of the ecosystem [4] [5] [6].

We first use the MA ecosystem assessment taxonomy to classify ecosystem services. Secondly, A static ecosystem service value assessment model is established by combining the expertise-based ecosystem service value approach established by XIE Gao-di et al., and the desired region is set as a. the specific modeling steps are as follows:

Step1: Classify Ecosystem Service Functions.
We adopted the method of millennium ecosystem assessment, and classified the ecosystem service functions into four categories, namely supply service, regulation service, support service and cultural service, and further subdivided each service into a total of 11 service functions.

Step2: Calculate the Equivalent Factors of Ecosystem Service Value Per Standard Unit.
We use the abbreviation of "standard equivalent" of XIE Gaodi to calculate the net profit of grain yield per unit area of farmland ecosystem in area A as 1 standard equivalent.

Let the main food products in region A be n. $S_i$ represents the percentage (%) of the area sown by type $i$ food products to the total area sown by all major food products in region A in a given year. $F_i$ represents the average net profit per unit area ($$/hm^2$$) of grain crop type $i$ in a specified year. If the ecosystem service value ($$/hm^2$$) of a standard equivalent factor is set as $D$, the calculation formula for $D$ is as follows:

$$D = \sum (S_i \times F_i)$$

Step3: Construct the Service Value Coefficient Table of Ecosystem Per Unit Area.
We refer to a large number of literature data, collected in recent years, experts to build different types of ecosystem and different kinds of ecosystem service function value equivalent, the basis of reference
at the same time the per unit area ecosystem service function value as the basis of the questionnaire, select the following based on the experience of the experts when inventory per unit area ecosystem service value [7]. Other countries' values can be compared to this method when making the scale (RMB/hm²*a).

By connecting the various ecological types of region A with the closest ecosystem types in the table, the value coefficient table of ecosystem service per unit area of region A that conforms to the actual situation can be obtained by using the value of D that has been calculated.

**Step4:** Calculate the Ecosystem Service Value of the Area

The area of different ecological types in the region can be obtained by searching remote sensing images and geographical statistical data of the region. The ecosystem service value of region A can be obtained by using the coefficient table of ecosystem service value per unit area.

B) Energy Conversion Method to Evaluate ESV

In order to ensure the rationality and accuracy of the model we established, to more comprehensively measure and evaluate the value of ecosystem services, we analyzed and calculated the ESV of the study area from another perspective by using energy conversion method.

Energy analysis method is to convert materials or energy of different grades and categories into a unified scale, namely solar emergy value, through energy conversion rate, to evaluate each resource index in the ecosystem by using the same scale.

**Step1:** Each feature was analyzed, and all features were taken into consideration to construct the functional relationship corresponding to the ecosystem service model with Pro, Reg, Sup, Cul as variables.

\[ ESV = f(Pro, Reg, Sup, Cul) \]

**Step2:** By referring to the literature listed in the question, we get the calculation method of emergy value conversion corresponding to each feature layer. The definition of variables is detailed in the literature. [8].

**Step3:** Then, the emergy value conversion rate of a certain production in the region during the specified research period is calculated by using the currency ratio evaluation method of emergy value, which is the ratio \( T \) of energy to money. Abstract ecosystem service functions are calculated and compared in the form of monetary quantity to evaluate the emergy value and monetary value of ecosystem service from a macro perspective. Energy conversion rate and energy currency value of ecosystem services are calculated as follows.

\[ T = \frac{ESV^*}{GNP}, ECV = \frac{ESV}{T} \]

It refers to the ratio of the sum of various emergy values used in a certain type of production to the gross national product (GNP) of that type of production in the region as the emergy value conversion rate during the research period (generally 1 production cycle, 1 year).

**Step4:** Finally, we obtain the ecosystem service value function in dollars:

\[ ESV = Pro + Reg + Sup + Cul \]

3.3.2. Resource Consumption Cost. In the process of accounting the cost of resource consumption, we take the three main categories of cultivated land resources, water resources and mineral resources as the characteristic factors of the subject of resource consumption, which are denoted as \( A, W, E \) respectively.

Then, we analyze each feature and take all features into comprehensive consideration to construct the functional relationship (in us dollars) corresponding to the resource consumption cost model:

\[ RCC = g(L, W, E) \]
\[ L = k_L, W = k_W, E = k_E, \] they represent the resource consumption cost land, water, energy.

### 3.3.3. Environmental Degradation Cost

Taking time as the main line, the theme layer is divided into three characteristic layers of pre-environmental cost, in-process environmental cost and post-environmental cost according to different stages of the production process, and they are denoted as \( F, M, A \) respectively.

Then, we analyze each feature and take all features into comprehensive consideration to construct the functional relationship (in us dollars) corresponding to the resource consumption cost model:

\[ EDC = h(F, M, A) \]

\[ F = k_F, M = k_M, A = k_A, \] they represent the environmental cost of ex ante, at working and ex post environmental cost.

### 3.4. Real Economic Costs of Land Use Projects

Based on the analysis in the above steps and the establishment of the ecosystem service evaluation model, we accumulated various economic costs, while ignoring the particularity of individual regions and ecosystems, and obtained a functional model used to estimate the real cost of land use projects, which is denoted as:

\[ EC = \varphi(ESV, RCC, EDC) = ESV + RCC + EDC \]

### 4. Cost benefit analysis

In order to use the model reasonably in the actual projects, we instantiate the model by selecting representative land use and development projects of small community projects to analyze the cost benefit.

Although small community projects have a small development area, their impact on ecosystem service value cannot be ignored. After the development of land projects, the land cover area of the regional ecosystem will inevitably change due to external factors, thus affecting its service value to a certain extent. We selected Yuyang district as the research object and calculated the economic cost of the project by using the equivalent factor method through the model established and analyzed its cost benefit by combining the value of ecosystem services. [9]

**Step1:** The service value coefficient of the local ecosystem is obtained by correcting the data of ecosystem service value of existing ecosystem service types per unit area. Considering the time factor of the price, we use the price index to revise the value coefficient table of ecosystem services in Yuyang district in 2007 again.

**Step2:** Remote sensing images were used to obtain the different land cover sizes of Yuyang district before and after the land project development as shown in the Table 1.

**Table 1** Structural change of land utilization before and after land consolidation of Yuyang District (2007-2013) (×10^4 dollars)

| Types of ecosystem services | Arable land | Garden | Woodland | The grass | Town village | Transportation land | Water area and facilities | Other land |
|----------------------------|-------------|--------|----------|-----------|--------------|---------------------|------------------------|-----------|
| Before implement           | 10341.0     | 974.2  | 4651.2   | 28981.4   | 3336.2       | 1325.7              | 1325.7                | 7457.1    |
| After implement            | 11951.5     | 984.4  | 46232.2  | 28689.0   | 3796.5       | 610.1               | 1021.7                | 7008.2    |
| Variable quantity          | 1610.5      | 10.2   | -318.9   | -292.4    | 460.3        | -715.6              | -305.1                | -448.9    |

**Step3:** According to the model, we get the ecosystem service value of all the land before and after the implementation of land remediation.

**Step4:** According to the formula \( ESV_{lm} = ESV_{after} - ESV_{before} \), the change of ecosystem service value before and after land project development is obtained, which is the ecosystem service value obtained from the implementation of land development project in Yuyang district as shown in the Table 2.
According to the data obtained from the analysis, we obtained the cost-effectiveness of land development projects in Yuyang district in terms of ecosystem service value was: -591.7K$.

5. Summary

The PSR model reveals the interrelationship between environmental pressure, state change and decision response. The idea of causal cycle guides us to take reasonable measures for different links in the face of environmental problems. In the land development project, the impact of the land development project on the environment represents the environmental pressure in the PSR model, and the resulting ESV changes correspond to the changes in the original state and resources of the environment; Based on the relationship revealed by the PSR model and combined with the dynamic ecosystem service value assessment model, we put forward expectations for the planning and management of land use projects, so that they can on the one hand make reasonable planning before the development to minimize the environmental pressure caused by the project. On the other hand, make optimal management decision response to the change of state after the completion of the project.

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