

# Research Progress and Prospect on Land Use and Ecosystem Services

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## Abstract

We sorted out land use and ecosystem services research progress in the past 20 years through the literature analysis and summarized the problems and prospects of developing this research field. Results show that Land use and ecosystem services are closely related and are still in a hot period. Most research focused on the valuation of ecosystem services of land. It has gone through the "Cognition - Theory - Practice" process in the research. The research still needs some help with regional differences, application, and assessment. In-depth research should be done on reflecting regional characteristics, strengthening the application, and comprehensive value assessment methods.

## Keywords

Ecosystem services value, prospect, ESV, land use, ecosystem services.

## 1. Introduction

Land provides various material bases for production and living, while ecosystems provide services that enhance human well-being. However, excessive development and utilization of land can lead to ecosystem destruction. Therefore, balancing land use and ecosystem stability has become essential in land resource management. In 1992, the UN identified the study of land use change as a priority for 21 century, and research related to land ecosystem services has since increased. Currently, this field has accumulated many research results. This article aims to review the research progress, summarize the trends, and provide a reference basis for related research and development.

## 2. Connotation and Relationship

### 2.1. Definition of Land Use and Ecosystem Services

There are multiple definitions of land use. Zhou<sup>[1]</sup> believes that land use refers to the allocation and utilization of land resources, while Fu<sup>[2]</sup> sees it as a management and governance activity. From the perspectives of different scholars, although the interpretations differ, land use essentially involves human activities on land to obtain products or services according to their own needs. From the perspective of the human-nature relationship, land use reflects human intervention in nature and is closely related to human production and daily life<sup>[3]</sup>.

There are also different views on the connotation of ecosystem services. Daily<sup>[4]</sup> believe that ecosystem services are natural conditions that maintain human survival and their various effects. He categorized the functions of ecosystem services into 13 types. Costanza<sup>[5]</sup> sees ecosystem services as various types of well-being humans obtain from ecosystems and categorizes them into 17 types. MA views ecosystem services as benefits humans obtain from various natural ecosystems and categorizes them into four types based on their functions. In summary, these definitions and classifications reflect the importance of ecosystem services for human beings.

## 2.2. Relationship between Land Use and Ecosystem Services

Land and ecosystem services are closely intertwined and mutually influencing. On the one hand, the land is an essential carrier of various ecosystems, and ecosystems provide services to humans through the land. On the other hand, land and ecosystem services mutually influence each other. Different land use practices have different impacts on the supply of ecosystem services. For example, forests can provide water source protection and carbon sequestration services, while grasslands and farmland can provide products such as forage and food. Conversely, excessive urban expansion can lead to the deterioration of the ecological environment. The relationship between the two is a complex system that is inseparable and mutually influencing.

## 3. Research Progress

In this study, we searched for nearly 20 years on CNKI using "land use" and "ecosystem services" as keywords. The search results are shown in Fig. 1.

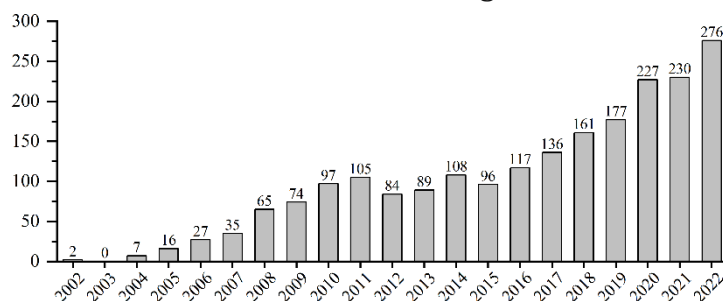


Fig. 1 Numbers of article

Regarding the number of publications, research in this field has gradually increased over the past 20 years and remains a research hotspot. The main themes of the literature are ecosystem, ecosystem services value, and land use. Further analysis reveals that most research focuses on assessing the value of land ecosystem services, with the primary methods being the equivalence factor and the Invest model. Regarding applications, the research mainly serves ecological compensation and ecological quality assessment.

## 4. ESV Assessment

Assessing ecosystem services value (ESV) provided by land is the most practical and commonly studied aspect in this field, which has undergone a process from "cognition" to "theory" and then to "practice" by scholars.

### 4.1. Cognition: Economic background

Economists have long recognized the importance of land in classical economics but failed to quantify its value. Land began to appear as an element in many classic economic growth analysis frameworks, such as the Malthusian growth model and Ricardo's Law of Rent. In the late 19th century, research in economics about land shifted to its exchange value. Some mainstream views, such as the Marxian labor theory of value, inspired commercializing land's ecological value. At the end of the 20th century, there was a debate in academia about the contribution of natural resources to economic growth. Costanza argued that the services provided by natural capital should be fully quantified and estimated the global ESV in 1997<sup>[5]</sup>. Subsequently, such research gradually became a global focus.

### 4.2. Theory: Supply and demand

The ESV is based on the Axiology. The utility and scarcity of goods affect the exchange value of goods and form the basis for measuring ecosystems' cost of goods and services. It is necessary

to measure people's willingness to pay to obtain an evaluation of the marginal utility of ecosystems. Assuming that ecosystems represent interests, Fig. 2 shows the relationship between the supply and demand curve. The supply curve of ecosystem services is vertical because economic prices do not affect it. When the supply of ecosystem services is zero, the demand approaches infinity, resulting in an infinite consumer surplus and total economic value. Currently, various methods for assessing the ESV are based on this theoretical model.

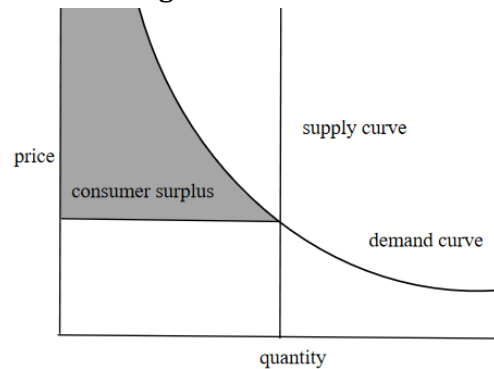


Fig. 2 Supply and demand curve of ecosystem services

#### 4.3. Practice: Classification of Assessment Methods

The assessment of ESV is centered on ecological economics theory, and these approaches to valuation can be classified into different categories based on different perspectives.

From the perspective of the development degree of ecosystems and natural capital, assessment methods are classified into the Actual Market, Substitute Market, and Simulated Market Methods. The Actual Market Methods are divided into the Market Value and Cost Expenditure Methods. These primary evaluation methods use market prices to determine the economic ESV. Substitute Market Methods indirectly estimate the ESV by measuring the production costs that are similar to the services. Commonly used methods include the Substitute Cost Method, Opportunity Cost Method, and Shadow Project Method. Simulated Market Methods measure the ESV by constructing a virtual market, with the Contingent Valuation Method and Contingent Valuation Method as usual.

From the perspective of the evaluation process, methods are classified into Direct and Indirect Assessing Methods. The Direct Assessing Methods quantitatively evaluate the ESV based on Market Theory and are divided into Objective and Subjective Assessing Methods. The Objective Assessing Method is based on the market value of actual or substitute products, while the Subjective Assessing Method is based on the subjective feelings of conditions or people. The Indirect Assessing Methods convert the obtained ecosystem services into specific values through certain methods and are divided into Energy and Material Conversion Methods. The Energy Conversion Methods assess value by converting solar radiation energy value data into specific values. The Material Conversion Methods evaluate the value of final or intermediate materials by converting primary data and are divided into the Final Material Conversion Method and the Intermediate Material Conversion Method.

ESV assessing methods are classified into Original Evaluation Method and Value Transfer Method from the perspective of evaluation data sources. The Original Evaluation Method is the traditional evaluation mode based on field data collection and economic evaluation methods, which mainly evaluate the processes, functional mechanisms of ecosystems, and their interaction with humans, and then evaluate the ESV, such as the Direct Market Value Method. The Value Transfer Method uses the valuable information of the "research area" in existing evaluation data to evaluate the value of the "policy implementation area." The primary purpose of this method is to establish a model to evaluate the ESV in the research area based on

matching the relevant indicators of the "research area" and "policy implementation area," saving the cost of data collection and improving evaluation efficiency.

## 5. Prospect

After reviewing and summarising the literature, we have identified the following problems with current research in this area and offer perspectives.

The manifestation of regional differences has yet to be fully considered. Different geographical conditions and the status of land use and ecosystems vary across different regions. However, using classification methods such as Costanza or MA in relevant studies on land ecosystem services has limited exploring the relationship between land use and ecosystem services and regional characteristics. Therefore, in the future, it is necessary to combine land use management practices with the theory of ecosystem service and actual conditions to refine the ecosystem service types of various types of land.

There needs to be more applications of the studies. Currently, the applications of the research are relatively small. The depth and breadth of ecological compensation, ecosystem service payments, and land use optimization planning still need further improvement. For example, evaluating the ESV needs to be more accurate and comparable in research, making it difficult to truly serve as a basis for guiding ecological compensation. In the future, under mature theoretical support, the indicator system and methods for assessing ESV should be clearly defined, ensuring that the evaluation results are consistent and comparable.

The assessment methods for ESV still need to be improved. Currently, various methods have general problems in specific applications and effects, such as the assessment of cultural service values often relying on the subjective intentions of consumers and needing more objectivity. In addition, most researchers use the Equivalence Factor Method of Costanza and Xie, which cannot reflect the spatiotemporal characteristics of the specific study area. In the future, it is necessary to consider the extensive use of multiple assessment methods to improve accuracy, determine the data precision and spatiotemporal scales of the assessment according to the purpose, and construct a sound assessment indicator system, so that the results are comparable.

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