

# Progress in Ecosystem Services Research Under the Evolution of Land Use Landscape Patterns

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## ABSTRACT

Land use change (LUUC) is the most intuitive reflection of human activities and a key driver causing changes in ecosystem types and landscape pattern evolution [162]. Changes in land use patterns, structure, composition, intensity, and spatial patterns due to natural and anthropogenic factors affect ecosystem processes such as species movement, soil erosion, and patterns of biodiversity distribution, which in turn affect a wide range of ecosystem services, such as food provisioning, flood storage, soil retention, and soil and water conservation, and ultimately affect human well-being. Most studies have shown that changes in land use landscape patterns affect ecosystem services through multiple pathways, including changes in biodiversity, ecosystem processes and habitats. Land use change and ecosystem services have a reciprocal relationship, and the evolution of land use landscape pattern will directly affect or change the structure and function of ecosystems, which ultimately affects ecosystem services, while the results of the ecosystem services assessment can also provide a scientific basis for the formulation of relevant policies. Therefore, understanding the relationship between the evolution of land-use landscape patterns and the response of ecosystem services can not only clearly reveal the process of land-use landscape evolution, but also more accurately assess the function of ecosystem services, which can promote the scientific formulation and effective implementation of relevant planning and protection policies.

## KEYWORDS

Land use change; Ecosystem services; Landscape patterns

## 1. INTRODUCTION

In recent years, related studies have attracted much attention, and a search of CNKI journals (1990-2022) with "ecosystem services" and "land use" as the subject headings reveals that the number of studies on the relationship and driving mechanism between the evolution of land-use landscape patterns and ecosystem services has continued to increase. The number of research reports on the relationship between the evolution of land use landscape patterns and the response of ecosystem services and the driving mechanism is still increasing. Therefore, the study of ecosystem services

under the evolution of land use landscape pattern has become a hotspot in the coupled study of social-ecological systems and natural ecosystems, and has become a research frontier for many disciplines, such as ecology, geography, urban and rural planning, and landscape architecture [1].

## **2. SPATIAL SCALE**

From the spatial scale, relevant studies on the relationship between land use and ecosystem services cover not only cities and villages, but also global scale, national scale, watershed scale, regional scale, district (county) scale, village and township scale, etc., as well as ecologically fragile and economically developed areas, and most of the studies on ecosystem services based on the evolution of the land use pattern are focused on the following aspects: (1) the impact of land use landscape pattern evolution on ecosystem services and its driving factors; (2) spatial and temporal changes in ecosystem service values and multi-scenario prediction; quantitative analysis of the relationship between spatial and temporal changes in land use patterns and their ecosystem service responses is a key link in enhancing ecosystem service functions as well as optimizing ecosystem management and land use patterns, especially the types of land use, landscape patterns, and changes in the intensity of land use will have a significant impact on ecosystem services. particularly the changes in land use type, landscape pattern and land use intensity will have important impacts on ecosystem services [2].

### **2.1. Changes in Land-Use Types**

Changes in land use types directly affect the amount of value of ecosystem services. For example, the distribution and migration of soil nutrients affects the amount of carbon sequestration, which in turn leads to changes in ecosystem services. For example, returning farmland to forests, prompting the increase of vegetation will significantly improve the local ecosystem services, at the same time, the increase in the area of woodland and grassland will significantly increase the water conservation capacity and carbon sequestration capacity of the river basin, and the large increase in construction land will significantly reduce the total value of ecosystem services in the watershed. Using the Guangdong-Hong Kong-Macao Greater Bay Area as a research object, Lin Meizhen et al. explored the relationship between landscape pattern changes and ecosystem service changes in the region during 2000-2015, and the results also concluded that the rapid urbanization process in the Guangdong-Hong Kong-Macao Greater Bay Area has led to significant changes in its landscape pattern and ecosystem services, with deepening landscape fragmentation and increasing spatial heterogeneity of the landscapes [3].

### **2.2. Ecosystem Type**

The evolution of land-use landscape patterns causes changes in the area of various ecosystem types and habitat fragmentation, which in turn affects ecosystem processes and biodiversity alterations such as species migration, changes in water quality, soil erosion and soils. Some studies have utilized landscape indices in order to analyze the relationship between land use and ecosystem services. For example, by analyzing the change of land use landscape pattern of temperate forests in Chile, it shows that the change of ecosystem services is closely related to the reduction of habitat area, landscape fragmentation and diversity; the rapid urbanization process directly affects the ecological function of regional landscapes, and the protection and use of urban landscape pattern and rational planning can effectively reduce landscape fragmentation, enhance ecosystem services and improve the ecological function of landscapes. Deng Chuxiong et al. assessed and analyzed the coupling relationship between the value of agroecosystem services and the level of urbanization in the hilly areas of central Hunan, and the results show that the change of land use landscape pattern has an important impact on agroecosystem services and presents a significant negative spatial correlation, indicating that strengthening the protection of vegetation, strictly controlling the proportion of construction land,

and promoting the intensive use of land resources will help to improve the conflict relationship between land use and agroecosystem services. Services [4].

### **2.3. land Use Intensity**

The increase in land use intensity also affects the trade-off relationship between provisioning and regulating services to varying degrees, and the increase in population exacerbates the intensity of land use and development, which directly leads to a reduction in supply capacity and affects human food stability and food security. For example, Wang Zhenpeng et al. explored the land ecological sensitivity changes based on the service value of the land system in the study area during 2000-2014 by utilizing 3S technology, taking Wanzhou District in Chongqing as the research object, and the results concluded that the response of the ecosystems to the intensity of land use is very significant, indicating that the intensity of land use is a key factor influencing the function of ecosystem services. Based on the InVEST model, Gong Jie et al. analyzed the multi-scale trade-offs among services and their causes for four typical ecosystem services, namely, soil conservation, water conservation, food supply, and habitat quality, using the Bailongjiang Basin in Gansu as the research object, and the results showed that the important factors affecting the degree of trade-offs among services and their scale effects were the intensity of land use and the variability of the landscape pattern of land use driven by human activities [5].

## **3. CONCLUSION**

InVEST models, geoprobe models, principal component analysis, logistic regression models, Markov models, grey prediction models, and Mann-Kendall tests, energy-value analyses, and scenario simulations are commonly used to characterize the response between the evolution of land-use landscape patterns and ecosystem services. When exploring how land use landscapes affect ecosystem services, the Life Cycle Analysis (LCA) method is often used to calculate their characterization factors. A large number of studies have also used remote sensing, climatic, topographic and socio-economic data, as well as models and methods such as geoprobes or principal component analysis, to reveal the impacts or cumulative effects of land use landscape change and climate change on ecosystem services.

In summary, clarifying the complex relationship between the evolution of rural land use landscape pattern and ecosystem services can effectively understand the process and mechanism of ecosystem services in rural areas, make up for the insufficiency of the existing research on the internal logic between land use, ecosystem services and multi-scenario driven response in rural areas, and at the same time understand the ecological environment change in the rural areas, which can help the formulation of rural land use planning and ecological protection policies. At the same time, understanding the ecological changes in rural areas will help to formulate land use planning and ecological protection policies in rural areas, which is of great scientific significance in promoting rural revitalization and sustainable regional development [6].

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