Spatial Relationship Between Cropland Ecosystem Service Value and Regional Economic Development in Gansu Province Based on Improved Equivalent Factors: A Postprint

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Abstract

To quantitatively analyze the value of cultivated land ecosystem services and its spatial relationship with regional economic development, this study employs an improved cultivated land equivalent factor to conduct a quantitative assessment of the cultivated land ecosystem service value in Gansu Province in 2014, and utilizes bivariate spatial autocorrelation to explore its spatial association with regional economic development. The results indicate: (1) The estimated cultivated land ecosystem service value in Gansu Province for 2014, based on GPP correction, is 4.96×10^{11} yuan, wherein the value of water resource supply function is negative, the ecosystem service value of food production function is relatively high, and the ecosystem service value of aesthetic landscape function is the lowest. (2) Bivariate spatial autocorrelation reveals a significant negative spatial correlation between per capita gross domestic product and cultivated land ecosystem service value, with a Moran' s I index of -0.2523. The local bivariate spatial autocorrelation LISA map also demonstrates that low-high clusters are predominantly distributed in the southeastern region, which is relatively underdeveloped economically yet possesses distinct ecological advantages; whereas high-low clusters are mainly located in the northwestern region characterized by rapid economic growth and relatively harsh ecological conditions. This study can provide decision-making references for ecological environmental management and regional economic development in Gansu Province, and offer a basis for achieving coordinated development that integrates economic growth with ecological protection.

Full Text

Ecosystem Service Value of Cultivated Land and Its Spatial Relationship with Regional Economic Development in Gansu Province Based on Improved Equivalent Factor

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Abstract

Ecosystem service value links natural ecosystems with socio-economic systems and represents a hot topic in ecology, geography, and related disciplines. The cultivated land ecosystem is closely related to national food security; therefore, quantifying its ecosystem service value and analyzing its relationship with regional economic development holds great significance. This study employs an improved equivalent factor method to quantify the ecosystem service value of cultivated land in Gansu Province, China, in 2014, and uses spatial autocorrelation analysis to explore the spatial relationship between cultivated land ecosystem service value and regional economic development at the county scale. The results show that: (1) As a major food supply land, the ecosystem service value of cultivated land in Gansu Province reached 4.96×10^{11} yuan in 2014, with relatively high food production function but relatively low aesthetic landscape function, essentially resulting from the backward economy; (2) Univariate spatial autocorrelation indicated significant positive correlation in space between per capita GDP and cultivated land ecosystem service value in areas with good regional economic development, with Moran' s I values of 0.5106 and 0.6041, respectively; (3) Bivariate spatial autocorrelation showed significant negative correlation in space between per capita GDP and cultivated land ecosystem service value, with a global Moran' s I of -0.2523. The local bivariate spatial autocorrelation LISA map also revealed that Low-High areas were mainly distributed in the southeastern region where economic development is relatively backward but ecological advantages are obvious, while High-Low areas showed basically the opposite pattern. This research can provide decision-making references for ecological environmental management and protection and regional

economic development in Gansu Province, and also offer guidance for coordinated development between economic growth and ecological protection.

Keywords: ecosystem service value (ESV); regional economic development; bivariate spatial autocorrelation; Gansu Province

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2.1.2 GPP Calculation Method

The GPP (Gross Primary Productivity) data were obtained from the MOD17 product, with a spatial resolution of 1 km. The GPP equivalent value for cultivated land ecosystem service was calculated based on the average GPP of 87 counties in Gansu Province in 2014, which was 1.9% higher than the national average GPP for cultivated land. The calculation formula is:

$$GPP_i = \frac{GPP_j}{GPP_G} \quad (i, j = 1, 2, \ldots, 87)$$

where GPP_i represents the GPP equivalent value of county i (87 counties total), GPP_j represents the GPP value of county j, and GPP_G represents the average GPP value for cultivated land.

2.2 Spatial Autocorrelation Analysis

Based on the principle of spatial autocorrelation, this study analyzes the spatial correlation characteristics between cultivated land ecosystem service value and regional economic development. Using annual precipitation of 400 mm as the boundary, areas receiving less than 400 mm precipitation were classified as arid regions. The analysis employed per capita GDP as the economic development indicator and utilized 2014 land use data with 200 mm precipitation isohyets. The spatial distribution patterns of cultivated land ecosystem service value and per capita GDP in Gansu Province were examined through global and local spatial autocorrelation analyses.

3.2.1 Global Spatial Autocorrelation Analysis

Using GEO_DA 095i and ArcGIS 10.2 software, this study conducted global spatial autocorrelation analysis on the ecosystem service value of cultivated land and per capita GDP in Gansu Province in 2014. The results showed that the Moran' s I value for cultivated land ecosystem service value was 0.5106, and for per capita GDP was 0.6041. At the significance level of =0.05, both passed the significance test (Z-score > 1.96), with p-values of 0.0002 and 0.0001, respectively, and confidence levels exceeding 99.98% and 99.99%. This indicates significant positive spatial autocorrelation for both cultivated land ecosystem service value and per capita GDP in Gansu Province, meaning their spatial distributions are not random but exhibit significant clustering patterns.

3.2.2 Bivariate Spatial Autocorrelation Analysis

The bivariate spatial autocorrelation analysis between cultivated land ecosystem service value and per capita GDP yielded a global Moran' s I of -0.2523, which passed the significance test at =0.05. This significant negative correlation indicates that counties with high economic development levels tend to have low cultivated land ecosystem service values, and vice versa. The LISA (Local Indicators of Spatial Association) cluster map further reveals that Low-High areas (low economic development but high ecosystem service value) are predominantly located in the southeastern region with obvious ecological advantages, while High-Low areas (high economic development but low ecosystem service value) show the opposite distribution pattern.

The total ecosystem service value of cultivated land in Gansu Province in 2014 was 4.96×10^{11} yuan, which represents a significant increase compared to the 2.79×10^{11} yuan in 2009. This growth reflects the increasing importance of cultivated land ecosystem services. However, the negative spatial correlation with economic development highlights the challenge of balancing economic growth and ecological protection, particularly in regions with different development levels and ecological conditions.

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Note: Figure translations are in progress. See original paper for figures.