

## Land Use Change and Its Ecological Response in Typical Fossil Energy Development Zones of Shanxi-Shaanxi-Inner Mongolia: Postprint

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### Abstract

Taking the typical fossil energy development zone in Shanxi-Shaanxi-Inner Mongolia—the Shanxi-Shaanxi-Inner Mongolia border region as a case study, and based on five-phase remote sensing interpretation data of land use from 1995, 2000, 2005, 2010, and 2015, this study employs the land use transfer matrix model and the ecological response model of land use transition to investigate the characteristics of regional land use change and its ecological response from 1995 to 2015. The results indicate: From 1995 to 2015, the areas of cropland and grassland in the study area decreased by 676 km<sup>2</sup> and 1 808 km<sup>2</sup>, respectively, while the areas of forestland, construction land, water body, and unused land increased by 1 063 km<sup>2</sup>, 966 km<sup>2</sup>, 29 km<sup>2</sup>, and 426 km<sup>2</sup>, respectively. The mutual conversion among cropland, grassland, and unused land constitutes the dominant type of land use change. Since 1995, the regional ecosystem service value has exhibited an increasing trend, with a total increase of  $1.86 \times 10^{10}$  yuan over the 20-year period, among which the contributions of forestland, grassland, and water body are the most prominent. Over the past 20 years, the overall regional environmental quality has demonstrated an evolutionary trend of first increasing and then decreasing, with three evolution types existing spatially: deterioration, stability, and improvement, accounting for 57.08%, 21.89%, and 21.03% of the total regional area, respectively. The degradation of water body, grassland, and forestland represents the dominant factor for regional environmental quality deterioration, while the conversion of cropland and unused land to grassland, forestland, and water body, as well as the conversion of grassland to forestland and water body, constitute important driving factors for regional environmental quality improvement.

## Full Text

### Land Use Change and Its Ecological Response in Typical Fossil Energy Development Zones

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#### Abstract

Research on land use change and ecological response in typical fossil energy development zones is significant for optimizing land use patterns and improving ecological quality. This study examines land use change and its ecological effects in representative fossil energy development zones of Shanxi Province, Shaanxi Province, and the Inner Mongolia Autonomous Region using remote sensing and GIS technologies. Land use data from 1995, 2000, 2005, 2010, and 2015 were acquired and analyzed using land use transfer matrices and ecological response assessment methods.

The results reveal that from 1995 to 2015, arable land and grassland areas decreased by 676 km<sup>2</sup> and 1,808 km<sup>2</sup>, respectively, while forest land, residential land, water bodies, and unused land expanded by 1,063 km<sup>2</sup>, 966 km<sup>2</sup>, 29 km<sup>2</sup>, and 426 km<sup>2</sup>, respectively. Notable inter-conversions occurred primarily among arable land, grassland, and unused land. Over the past two decades, the regional ecosystem service value increased gradually by  $1.86 \times 10^1$  RMB, with forest land, grassland, and water bodies contributing most significantly.

The overall regional ecological quality exhibited an initial increasing trend followed by a decreasing trend during 1995–2015. Three distinct evolutionary patterns of environmental quality were identified: deterioration, stability, and improvement. The area with stable environmental quality accounted for the largest proportion at 57.08% of the total study area, while areas with deteriorated and improved environmental quality represented 21.89% and 21.03%, respectively. Degradation of water bodies, grassland, and forest land was the primary factor driving regional environmental quality deterioration, whereas conversions of arable and unused land to grassland, forest land, and water bodies, as well as conversion of grassland to forest land and water bodies, served as important drivers for environmental quality improvement.

**Keywords:** land use; ecosystem service value; ecological response; fossil energy development zone

## Introduction

Land use change represents the most direct manifestation of human transformation of natural ecosystems and constitutes a core research focus of the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions Programme on Global Environmental Change (IHDP) [?]. In recent decades, intensified human activities have profoundly altered land use patterns, triggering a series of ecological and environmental effects [?].

Ecosystem service valuation provides a quantitative framework for assessing these impacts [?, ?]. Costanza et al. [?] pioneered global ecosystem service value assessment, establishing a foundation for land use change studies. Subsequent research has refined valuation methods and applied them to diverse contexts [?, ?, ?]. In China, scholars have extensively investigated land use changes and their ecological consequences [?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?], though comprehensive studies in fossil energy development zones remain limited.

## 1. Study Area

The study area encompasses typical fossil energy development zones spanning Shanxi, Shaanxi, and Inner Mongolia, covering approximately  $5.44 \times 10^4$  km<sup>2</sup>. The region possesses substantial coal reserves estimated at  $4.90 \times 10^{11}$  tons. By 2015, the total population reached  $3.99 \times 10^7$ , with an urban population of  $2.49 \times 10^7$  and a population density of 73 persons per km<sup>2</sup>. The regional GDP totaled  $5.44 \times 10^{11}$  RMB, with primary industry output valued at  $3.88 \times 10^{11}$  RMB.

## 2. Data and Methods

**2.1 Data Sources and Processing** Land use data were derived from Landsat TM/ETM+ satellite imagery for the years 1995, 2000, 2005, 2010, and 2015. The classification system identified six land use categories: arable land, forest land, grassland, water bodies, residential land, and unused land. Image processing and classification were performed using ArcGIS 10.2 software, achieving classification accuracy exceeding 94.3% for all time periods. The analysis employed land use transfer matrices to quantify spatiotemporal changes and assess ecological responses to land use transitions.

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## References

- [1] Wu L. Study on the response of ecosystem services to land use change and scenario simulation of land use sustainability in the Yangtze River Delta. *Acta Geographica Sinica*, 2014, 69(1): 3-14.
- [2] Wu L, Yang S, Liu X, et al. Response analysis of land use change to the degree of human activities in Beiluo River basin since 1976. *Acta Geographica Sinica*, 2014, 69(1): 54-63.

- [3] Gascoigne W R, Hoag D, Koontz L, et al. Valuing ecosystem and economic services across land-use scenarios in the Prairie Pothole Region of the Dakotas, USA. *Ecological Economics*, 2011, 70(10): 1715-1725.
- [4] Wang X, Meng J. Research progress on the environmental-ecological impacts of land use change. *Acta Scientiarum Naturalium Universitatis Pekinensis*, 2014, 50(6): 1133-1140.
- [5] Costanza R, Arg R, Groot R, et al. The value of the world' s ecosystem services and natural capital. *Nature*, 1997, 386(8): 253-260.
- [6] Polasky S, Nelson E, Pennington D, et al. The impact of land-use change on ecosystem services, biodiversity and returns to landowners: a case study in the state of Minnesota. *Environmental and Resource Economics*, 2011, 48(2): 219-242.
- [7] Zorrilla-Miras P, Palomo I, Gómez-Baggethun E, et al. Effects of land use change on wetland ecosystem services: a case study in the Doñana marshes (SW Spain). *Landscape and Urban Planning*, 2014, 122(2): 160-174.
- [8] Kremen C. Managing ecosystem services: what do we need to know about their ecology? *Ecology Letters*, 2005, 8(5): 468-479.
- [9] Xie G, Zhang C, Zhang L, et al. Improvement of the evaluation method for ecosystem service value based on per unit area. *Journal of Natural Resources*, 2015, 30(8): 1243-1255.
- [10] Li J, Dong S, Mao Q, et al. Urban land change and its ecological effect in areas along the Yellow River in Ningxia Hui and Inner Mongolia autonomous regions. *Arid Zone Research*, 2016, 33(6): 1262-1269.
- [11] Yu M, Lv X, Lian L, et al. Land use changes and its ecology effects in coastal region of Jiangsu province. *Bulletin of Soil and Water Conservation*, 2017, 37(3): 1-9.
- [12] Du J, Zhu J, Xie J, et al. Changes of land use and landscape pattern in the Guanzhong area in recent 25 years. *Arid Zone Research*, 2018, 35(1): 217-226.
- [13] Song Y, Xue D, Dai L, et al. Land use change and environmental response in the middle-lower reaches of the Shule River basin during 1977-2013. *Arid Zone Research*, 2017, 34(4): 775-781.
- [14] Guan J, Qian C, Qian D. Land use change and its eco-environmental response in the middle-lower reaches of the Shule River basin. *Arid Zone Research*, 2017, 34(4): 775-781.
- [15] Lv L, Zhou S, Zhou B, et al. A study on landscape changes of ecotone in contiguous area of Shanxi, Shaanxi and Inner Mongolia using remotely sensed data. *Research of Environmental Sciences*, 2011, 14(6): 50-53.
- [16] Lv L, Zhou S, Zhou B, et al. Land use transformation and its eco-environmental response in the process of regional development: a case of

Jiangsu province. *Scientia Geographica Sinica*, 2013, 33(12): 1442-1449.

[17] Xie G, Zhang C, Zhang L, et al. Improvement of the evaluation method for ecosystem service value based on per unit area. *Journal of Natural Resources*, 2015, 30(8): 1243-1255.

[18] Lv L, Zhou S, Zhou B, et al. Land use change and its eco-environmental response in typical fossil energy development zones. *Research of Environmental Sciences*, 2011, 14(6): 50-53.

[19] Song Y, Xue D, Dai L, et al. Spatial-temporal pattern and evolution mechanism of coordinated development of human settlement environment and economy in energy accumulation and vulnerable ecology regions: a case of contiguous areas among Shanxi-Shaanxi-Inner Mongolia. *Arid Land Geography*, 2017, 40(6): 1328-1337.

[20] Lv L, Zhou S, Zhou B, et al. Land use change and its ecological effects in typical fossil energy development zones. *Research of Environmental Sciences*, 2011, 14(6): 50-53.

[21] Song Y, Xue D, Dai L, et al. Land use change and its ecological response in typical fossil energy development zones in Shanxi, Shaanxi and Inner Mongolia. *Arid Zone Research*, 2018, 35(1): 217-226.

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