

LETTER TO THE EDITOR

Analysis of Pattern Evolution Model of Agricultural Environment Ecological Landscape Based on Fuzzy Mathematics

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Agricultural landscape pattern is the internal driving force of industrial development planning. In order to solve the problem that the traditional landscape pattern evolution model has low fitting degree between the result and the actual situation, a model of agricultural environment ecological landscape pattern evolution based on fuzzy mathematics was proposed. The agricultural ecological landscape is divided into natural ecological landscape, residential landscape, production landscape and public service landscape; Remote sensing data preprocessing of agricultural landscape is realized through five steps: band combination, geometric correction, image registration, image clipping and image enhancement; Based on the index extraction equation of landscape pattern constructed by fuzzy mathematical reasoning, the evolution model of agricultural environmental ecological landscape pattern was constructed by fuzzy mathematical theory. The experimental results show that the model has a high degree of fitting between the results and the actual results, which verifies the practical application effect of the model.

Fuzzy mathematics; agricultural environment; ecological landscape; pattern; evolution model

1 Introduction

Landscape ecology is a very dynamic field of ecological research at present, including the research of landscape ecological structure, function, pattern evolution, etc., which has important application value for the study of spatial heterogeneity, space-time scale effect and human activities in geoscience and other related domains. Landscape spatial pattern is an important content in landscape ecology, which refers to the arrangement of landscape patches in space and is the result of different degrees of ecological processes. The industrial structure of modern agriculture has changed as follows: the rural industry has changed from the agriculture-oriented structure to the structure of joint development of agriculture and non-agriculture; the upgrading and transformation of industrial structure affects the change of rural environmental landscape pattern, and brings about new production and living modes. The spatial expansion of new production activities will bring about new spatial growth and demand. The new type of agricultural space needs to join the new industrial planning to fill the vacancy of agricultural industry and generate reasonable economic income for villagers. Agricultural landscape pattern is the internal driving force of rural industry development planning. The concept of landscape pattern can be divided into two levels: one is the specific form perceived visually; the other is the metaphysical way with human organization factors added, which is a new agricultural planning concept based on the traditional spatial planning concept and attracting industry

implantation. Urbanization has promoted the social and economic progress of traditional agriculture, and the agricultural landscape pattern has undergone drastic changes. Many researchers have carried out academic discussions and researches on agricultural environmental landscape pattern, agricultural landscape planning, agricultural development mode and other issues.

Xinping Yuan, Yi Liu published an article in the *Ekoloji* (Issue 107, 2019), entitled “Analysis of Vegetation Landscape Adjacency Characteristics based on Rural Wetland Ecosystem”. This paper deeply analyzed the adjacent characteristics of vegetation landscape in the rural wetland ecosystem (Yuan and Liu 2019). The relative abundance, relative height and relative coverage of vegetation landscape were calculated by measuring relative coverage and relative density. The types and characteristics of vegetation landscape were analyzed with landscape pattern calculation software. On this basis, the relationship between the structure and spatial configuration of vegetation landscape was obtained by using the vegetation landscape pattern index analysis method. Accorded to the four indexes of adjacent length, percentage of adjacent length, number of adjacent edges, number of adjacent edges and the ratio of the number of adjacent edged to the number of patches, the adjacent feature analysis method of vegetation landscape was adopted to analyze the adjacent features of vegetation landscape and wetland in the rural wetland ecosystem and the characteristics of development and construction land. The stress degree function of vegetation landscape was constructed by wetland ecological security analysis method. Accorded to the degree of landscape stress and the degree of ecological security risk, the ecological security status of wetland ecosystem was analyzed. Based on this article, the evolution of agricultural ecological landscape pattern is studied.

Wu et al. proposed a prediction model of rural landscape pattern evolution based on life cycle. Taked Jinjing town in Dongting lake district as an example, the evolution process of rural landscape pattern is analyzed by life cycle theory. The evolution period curve of rural landscape pattern was simulated, and the evolution period of rural landscape pattern was predicted. Coupled with the ca-Markov model, a set of prediction and simulation model in line with the evolution law of rural landscape pattern was established, However, the actual application effect of the model was not good, and there was a problem of low fitting degree between the results and the actual situation. Ji et al. proposed a landscape pattern evolution model based on Markov model. With the support of RS and GIS technology, and the help of ENVI tool, the landscape pattern distribution map of mari oasis in turkmenistan in 1988 and 2010 was obtained, and the landscape pattern prediction of this region was based on the Markov model, determined the initial state matrix and transition probability matrix of the landscape pattern. X2 test showed that the simulated value does not match the measured value satisfactorily. On this basis, the driving force of the evolution process of landscape pattern was analyzed from the perspectives of natural factors and human factors.

In order to solve the problem of the low fitting degree between the results and the actual situation of the traditional ecological landscape pattern evolution model, an agricultural environmental ecological landscape pattern evolution model based on fuzzy mathematics was constructed.

2 Idea Description

2.1 Classification of agricultural environmental ecological landscape types

Landscape classification is the influencing factor of the evolution of agricultural spatial pattern and is often used as the basis of landscape spatial pattern and spatial planning. In terms of space, it is the carrier of production activities, residence and consumption activities and public infrastructure (Cao et al. 2016). Agricultural environmental ecological landscape includes natural ecological landscape, residential landscape, production landscape and public service landscape (Junior et al. 2019).

2.2 Remote sensing data processing of agricultural environmental ecological landscape pattern

2.2.1 Time and space dimensions

Ecology puts forward: “if we want to understand the relationship between pattern and process correctly, we must realize that it depends on the characteristics of scale”. The choice of node scale in time period and spatial pattern will directly affect the function and nature of process and pattern. The rural ecological landscape pattern is not only the place of economic activities, but also the carrier of social policy reform.

2.2.2 *Space scale*

The object and purpose of the research determines the choice of scale precision, and the village area and the village system it contains constitute the main part of the pattern of agricultural ecological landscape. At the level of spatial planning, to build a reasonable rural landscape space, it is necessary to complete the design of the program under the constraints of social policies and economic conditions at the previous level, and make overall consideration of the development relationship between the city and the villages, villages and villages. Remote sensing technology is an important tool to study and analyze the process of landscape scale change. It extracts the information of land use and spatial distribution structure from the remote sensing data of different scales and can intuitively see the evolution process of spatial pattern (Mi et al. 2015).

2.2.3 *Remote sensing data preprocessing*

Remote sensing image has the characteristics of multi - platform, multi - sensor, multi - phase and amplitude - splitting. Due to the limitations of the space, spectrum, time and radiation resolution of the remote sensing system, geometric distortion, atmospheric extinction, radiation distortion and other phenomena will occur in the imaging of remote sensing images to varying degrees. The original observation data cannot well meet the research requirements, so it is necessary to conduct data preprocessing for the acquired original remote sensing data (Chen et al. 2016). This study used ENVI 5.1 and Erdas Imagine 8.6 remote sensing image processing software to preprocess the original remote sensing data of agricultural environmental ecological landscape pattern in different periods. The main steps are as follows:

- (1) Band combination: The combination of images of different bands in the same region can highlight different information on the image, which not only synthesizes the spectral characteristics of each band, but also enhances the display effect of different ground objects on the image. Considering the richness of information and the possibility of image interpretation, band 5, band 4 and band 3 were selected for combination and given RGB channels respectively. The synthesized image conforms to the visual habits of human beings, and the colors of objects in different regions are clearly distinguished, which facilitates the selection of classification samples for image classification.
- (2) Geometric correction: Geometric correction includes geometric rough correction and geometric precision correction. Geometric rough correction is a correction for the cause of distortion. The remote sensing data obtained has been corrected by geometric rough correction. The purpose of geometric precision correction is to change the geometric distortion of the original image. It uses the ground control point to obtain the geometric distortion model of the standard image and the distorted image, and then uses this model to correct. In this paper, WGS_1984_UTM_Zone_51N was selected as the projection coordinate system to carry out geometric precision correction for remote sensing images of agricultural ecological landscape pattern in different periods.
- (3) Image registration: Taking the 2018 remote sensing image (corrected) as the reference image, obvious ground object points were selected to register the images in 1990, 2002 and 2010, respectively.
- (4) Image cropping: By using ArcGIS9.3 software, the administrative vector boundary of Wuzhong district was extracted by creating polygon layers and digitizing Wuzhong district administrative zoning map. The Extract by mask command in ArcTool Box was used to conduct mask processing for the four-phase remote sensing images.
- (5) Image enhancement: Due to atmospheric scattering, reflection, refraction and other reasons, the acquired

remote sensing images usually have problems such as noise interference, insufficient contrast, image blurring and so on. In this paper, image enhancement methods are space domain image enhancement and frequency domain image enhancement.

2.3 Analysis of driving factors of pattern change of agricultural environmental ecological landscape

The change of landscape pattern can objectively reflect the global change and the impact of human activities on the natural ecological environment. The driving factors of landscape pattern change are the elements guiding the change of landscape pattern. The study of the driving factors is helpful to understand the relationship between human activities and the evolution of landscape pattern (Chu et al. 2018).

The impact of climate change on the ecological environment has attracted people's attention, and its related research has also become the focus of scientists and governments, and the research on climate change and ecosystem response has become one of the important contents of ecological research. Human activities have a certain interference effect on the regional landscape, and with the progress and development of human beings, the rapid increase of population density interferes with the landscape pattern more frequently.

2.4 The evolution model of agricultural environment ecological landscape pattern is constructed based on fuzzy mathematics

2.4.1 Selection of landscape pattern index

Landscape pattern index can highly concentrate landscape pattern information and reflect some aspects of its structure composition and spatial configuration, including patch scale level, type scale level and landscape scale level. Landscape pattern index can reflect the changing characteristics of each rural ecological landscape pattern.

2.4.2 Model building

In the process of extracting landscape pattern index from remote sensing data, the method of inference is mainly used to extract the landscape pattern index of massive remote sensing data. In clustering and the massive remote sensing data mining, the principle of landscape pattern index extracted from remote sensing database for data stream filter, based on the data characteristics of information flow in the spatial restructuring and pattern recognition, classification and pattern for data found that meet the conditions for data selection and calibration data features of expression, the agricultural ecological environment landscape pattern index extraction.

Suppose the dimension of feature set of massive data is m , let $A_j(L)$ be the information clustering center of landscape pattern index characteristics ($j=1,2,\dots,k$). Calculate the distance of cluster center. In morrey-herz convex space of finite dimension, given constant symmetric matrices z_1, z_2, z_3 , taking the eigenspace vectors y_1, y_2, y_N as samples, the exponential extraction equation of landscape pattern under fuzzy mathematical reasoning is:

$$u_n = x^T(k)Px(k) + \sum_{i=1}^{k-1} x^T(i)K^T \quad (1)$$

In the above equation, $x^T(k)$ represents the change equation of landscape index, P represents the constraint condition, $x^T(k)$ Represents the exponential distribution equation of landscape pattern. Based on the above equation and fuzzy mathematical theory, the evolution model of agricultural environmental ecological landscape pattern is constructed:

$$S = u_n - \Delta u + |u|^4 u, (u, \partial_t u) \Big|_{t=0} = (u_0, u_1) \in H_x^{sc} \times H_x^{sc} \quad (2)$$

3 Result

In order to prove the practicability of the evolution model of agricultural environment ecological landscape pattern

based on fuzzy mathematics, a simulation experiment is needed. The experimental area is a local rural area and surrounding agricultural land, and the fitting degree between the model and the actual is analyzed. The experimental results are shown in figure 1.

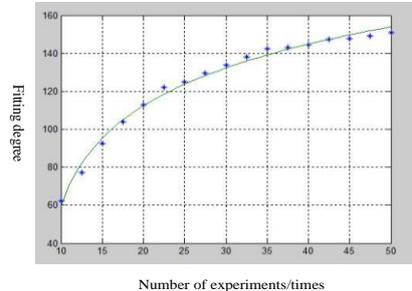


Figure 1 shows the degree of fitting between the results and the actual data

Analysis of the figure above shows that although the model constructed has a high degree of fitting with the actual situation, it has verified the comprehensive practicality of the model constructed and is a good supplement to the research of Xinping Yuan et al.

4 Discussion

The change trend of landscape pattern is a complex process influenced by many factors such as nature, society and economy, and the evolution process is affected by many aspects at the same time. The experimental results show that the model has a high fitting degree with the actual results. The main reason is that the model USES five steps of band combination, geometric correction, image registration, image clipping and image enhancement to realize remote sensing data preprocessing of agricultural landscape. The fuzzy mathematical reasoning method was used to construct the index extraction equation of the landscape pattern to improve the accuracy of the results.

5 Conclusion

Agricultural land is the fundamental material basis of rural space composition. Its dynamic evolution reflects the trajectory of agricultural growth. Through its evolution research, it can grasp the characteristic trend of agricultural spatial structure succession. Therefore, a pattern evolution model of agricultural environmental ecological landscape based on fuzzy mathematics is proposed. This model can be used for reference to study the dynamic evolution process of landscape in the region and predict the future trend of change. In addition, it can also lay a solid foundation for the formulation of correct agricultural development plans and promote the rational and orderly development of rural areas.

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