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Dynamic Study of Agricultural Landscape Pattern in the Arid Zone of Ningxia Based on the RS and GIS Techniques

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Abstract

Based on RS and GIS Technology, we choose arid zone in the middle of Ningxia province as the study area , Classificated the remote sensing images in 2006, 2009, 2012 and 2015with the method of human computer interaction., and we got the classified thematic map of agricultural landscape between 2006 and 2015. Used Fragstats software, we calculated the agricultural landscape pattern index in the study area and analyse the characteristics of agricultural landscape pattern changes. The results show that the changes of agricultural landscape in the study area are obvious. Between 2006 and 2009, the number of patches increased, the average patch area decreased, the patch density increased and the fragmentation was obvious. And after 2012, the landscape aggregation degree of the whole continued to decline, which indicates that the distribution of various types of patches in the landscape has been balanced, and the diversity and evenness index of the landscape has increased steadily, which reflecting the distribution of different types of agricultural landscape in the study area is relatively uniform, the landscape heterogeneity is increased

Keywords: *Agricultural landscape; Pattern; Change; Ningxia arid zone*

1. Introduction

Interaction of agricultural landscape has the certain regularity and high degree of spatial heterogeneity, which is the most widely distributed landscape types in the world.[1] With comprehensive intervention mechanism, complexity, region, improve agricultural landscape changes compared with the natural landscape, directly affect and restrict the ecological process of different geographical units.[2]As an important landscape types of arid zone of northwest China, due to the intensive and extensive area of land, or mixed mode of operation and management, in growth, broken space combination and the mode of agricultural landscape has changed. Use arid zone in Ning Xia as an example, this paper analysis the region for nearly 10 years the change of agricultural landscape pattern, discussed the main factors of landscape pattern change, the dynamic adjustment of agricultural structure, mode of production, optimize the agricultural landscape pattern and so on to provide decision-making reference and basis.

2. Regional Overview and Research Method

2.1 Data Acquisition and Processing

The central arid zone of Ning Xia loess plateau transition zone, located in dry sandstorm area, near the district and county in northern China, wu chung master li tong area cities and Yin chuan LingWu; And eastern Inner Mongolia, Ding Bian county in Shan xi, Gan Su province neighbors county; Gu yuan city in the south of

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the initial state and xi ji county; Western border yuan Ping chuan area, Gan su province and Beijing. Including existing Hong Si Bao existing regional Administrative department, the childlike innocence, Ning Xia four counties (area), remote sensing, covers an area of 18500km^2. Belong temperate semi-arid region, the region is a typical continental climate characteristics, the lack of rain, the annual average rainfall of 277.8 mm, strong evaporation, average annual evaporation is 2168.75 mm, annual average dry degree is 2.95, hydrological environment is bad, the shortage of water resources. The Dust weather frequently, mainly concentrated in March. The flying Dust or sand in the north and south is according to the characteristics of the flight and give priority to sand Dust weather. Dust storm occurred frequently, other bad weather, such as hail, the frost also frequent.

In this study, TM / ETM images as the basic data source, according to the image of the availability and continuity of the dynamic changes, were screened out from 2006 to 2015, a total of 4 remote sensing images, each 4 TM images in the image data, the receiving time between July and October, for study area images in this time is the most vigorous growth of vegetation coverage, the best season, on behalf of the annual state of the vegetation, the quality of remote sensing images selected better, basically covering the cloudless or cloudiness is less than 5%, to ensure the reliability of data acquisition and quantitative . The study area of all TM / ETM receiver in satellite images the ground station have made correction system, projection system for WGS84, but relatively rough, the need for further accurate correction, in order to meet the needs of this study. According to the Yanchi County, Tongxin County, Haiyuan County, Hongsipu area 1: 50000 topographic map, using envi software of geometric precision correction module for correction.[3]Because research area with a wide range of different periods are used in the four scenes of remote sensing images. So, first of all, by the mosaik module in envi software for remote sensing image mosaic[4]. Opened in TM4,3,2 band, the drought zone of Middle Ningxia border vector(shape format) files, under the envi. Through the mask realization of remote sensing images cropped.

2.2 Agricultural Landscape Classification System

Comprehensive comparison of national and academic research results and classification system, the actual situation of the reference of the remote sensing image, based on regional natural geographical conditions, agricultural characteristics and land use status, determine the division of agricultural landscape types in the study area was classified as two grades. Among them, a classification including cultivated land, woodland, grassland, land for urban and rural residents, waters and unused land. Based on a classification on arable land is divided into two types of irrigated land and dry land; forest land is divided into forest, shrub forest, sparse forest and non forest grassland is divided into 3 categories; high coverage grassland, medium coverage grassland, low coverage 3 types of grassland; unused land divided into sandy land and other unused land. The classifications and meanings are shown as Table 1.

Table 1. Agricultural Landscape Classification System in the Central Arid Zone of Ningxia 3. Data Source and Study Method

First-level classification （Classification Number）	Second-level classification （Classification Number）	Meanings
Cultivated land（1）	Irrigated land (11)	Water supply and irrigation facilities
	Dry cultivated land (12)	No irrigation facilities, only natural precipitation of arable land
woodland（2）	Woodland (21)	More than 0.2 of the forest canopy coverage of more than 30% of the shrub land< 0.2 canopy of arbor and
	Shrub woodland (22)	shrub forest coverage is less than 30%, and not into the forest
	Sparse forest land and forest land (23)	More than 30% types of grassland coverage The coverage is more than 10%, and less than 30% of the grassland coverage is more than 5%, and less than 10% of the grassland
Grassland (3)	High coverage grassland (31)	More than 30% types of grassland coverage
	Medium coverage grassland (32)	The coverage is more than 10%, and less than 30% of the grassland
	Low coverage grassland (33)	coverage is more than 5%, and less than 10% of the grassland
Waters (4)	Waters (41)	Natural and artificial water bodies, including rivers, lakes, reservoirs, ponds, *etc*.
Urban and rural industrial and mining land (5)	Urban and rural industrial and mining land (51)	Urban and rural residents, industrial and mining land, transportation land, *etc*.
Unused land (6)	Sandy land (61)	Vegetation coverage of the 5% deserts and mobile Sands
	Other unused land (62)	Including the saline alkali land, bare land, bare rock, gravel, and other unused land

2.3 Remote Sensing Image Classification

After the GPS location and field investigation, the satellite images reflect the size, shape, color, brightness and texture as the main index to establish the visual interpretation of the signs. The ETM / TM images are shown as Table 2.

Table 2. ETM / TM Images of Agricultural Landscape in Arid Zone of Ningxia

Classify	Remote sensing image interpretation signs (standard false color composite)
Irrigated land	And other surrounding the unification of the contrast of red or deep red color, regional segmentation, edge is clean and tidy
The dry land	Mostly red, light red or dark grey patches, uniform color, the shape of a regular, flat, flake or zonal distribution
The forestland	Present a dark red, dark red, and even black red, bright color, color is uniform
Shrub land	Red, dark red, uniform texture, shape is irregular, rough image texture
Sparse woodland and woodland	Pink dot of bright red, dark color and uneven tone, texture roughness
High coverage grass	Red, dark red or yellow, it is big patches, irregular shape, the texture is fine
Coverage in the grass	Reddish or grayish, large patches, irregular shape, the texture is fine
Low coverage grassland	Pale blue, sage green, or black gray, big patches, irregular shape, the texture is fine
The waters	Light blue, dark blue to dark blue, black, uniform color, edge is clear
Urban and rural residents of industrial land use	Its or pale blue, shape rules, the edge is clear
The sand	Light gray, green, light gray or gray, a wave or worm-like, clear edges
Other unused	Light gray, light gray, bright white

Based on the above interpretation symbol, reference to other auxiliary information, in the remote sensing processing software EVNI, on the basis of man-machine interactive visual interpretation interpretation, using the maximum likelihood supervised classification method of computer interpretation of remote sensing image classification, 2006, 2009, 2012 and 2015 in arid agricultural landscape classification of middle Ning Xia thematic map , as shown in Figure 1. Interpretation results with the method of random sampling survey for field investigation to verify and GPS positioning, validation results show that the classification accuracy can meet the needs of the research.

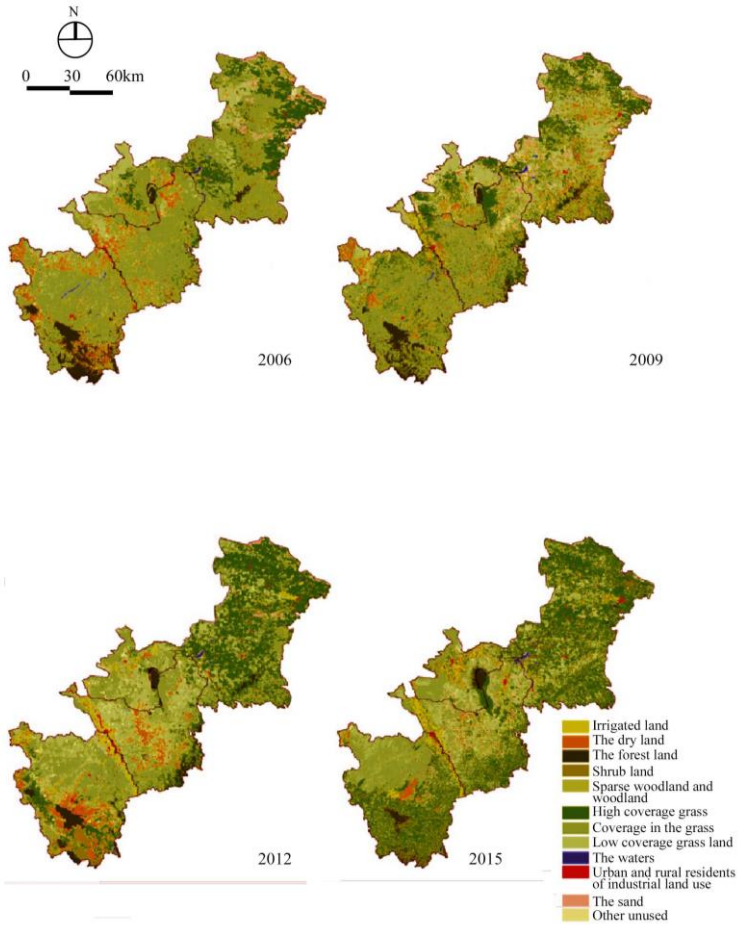

Figure 1. Agricultural Landscape Classification of Different Years in Ningxia Arid area

2.4 Selection and Calculation of Landscape Pattern Index

According to the significance and usefulness of the purpose of the present study and the landscape index, selects the ecological significance of relatively clear plaque type index and landscape level index, of Ningxia in central arid zone agricultural landscape elements and the overall landscape structure dynamic characteristics and reflect in the study area during the past 20 years the dynamic changes of the agricultural landscape ecology rules.[5] In this study, we chose the patch type index (PLAND), patch density (PD), average patch area (MPS), landscape shape index (LSI), NP (LPI), (SHDI), Shannon (SHEI) , and Shannon (CONTAG). According to the classification of the 2006, 2009, 2012 and 2015, the Fragstats software is used to calculate the landscape pattern index, and the ecological status and spatial variability of the region are analyzed based on this.

3. Results and Analysis

3.1 Plaque Index

The calculation results of FRAGSTATS software were calculated. The values of PLAND, PD, MPS and LSI in the area of the study area were obtained, as shown in Fig.ure 2-5.

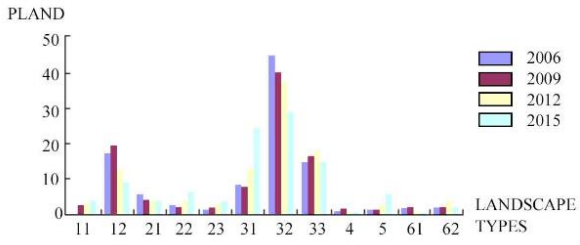

Figure 2. Changes of PLAND in Agricultural Landscape in Different Periods

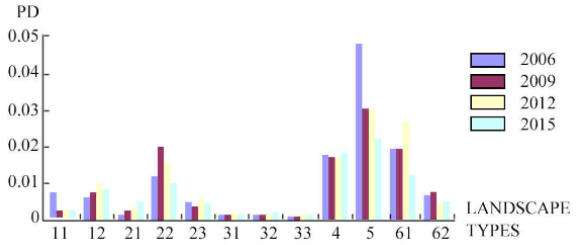

Figure 3. Changes of PD in Agricultural Landscape in Different Period

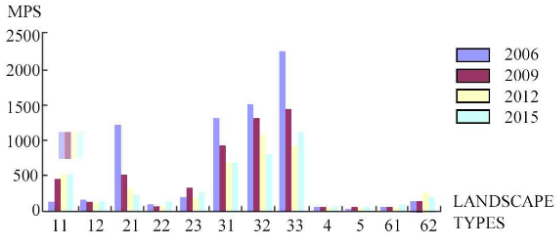

Figure 4. Changes of MPS in Agricultural Landscape in Different Periods

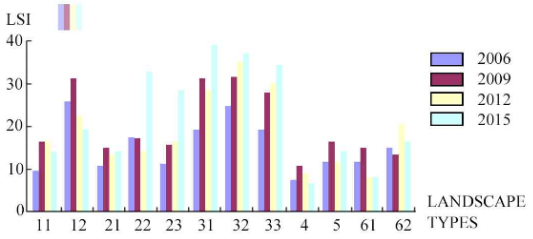

Figure 5. Changes of LSI in Agricultural Landscape in Different Period

According to the purpose of this study and the significance and practicability of the landscape index, selects the ecology meaning relatively definite index and landscape level index, patch type analysis in central ningxia drought with all kinds of agricultural landscape elements and dynamic features of the overall landscape structure reflects nearly 10 years in the study area of agricultural landscape ecology law of dynamic change.[6] Plaque type index are selected in this study (PLAND) shows the percentage of the landscape area, patch density (PD) (MPS), average patch area, landscape shape index (LSI); Landscape level number (NP), largest patch index, plaque index (LPI), Shannon diversity index (SHDI), Shannon evenness index (SHEI), landscape aggregation degree (CONTAG). According to the arid zone of middle Ningxia in 2006, 2009, 2012 and 2015 interpretation classification figure, using grid Fragstats software version, the landscape pattern index is calculated, based on this, analysis of the regional ecological condition and spatial variation characteristics.

In each of the patch types index, MPS and PD reflect the changes of the size of the patch. PD reflects the degree of the landscape fragmentation, and LSI reflects the shape characteristics and the changes of different patches. Overall, 2006-2009, the number of landscape patches in the study area increased, the average patch area decreased, the patch density was large, the fragmentation was obvious, and the study area was significantly affected by human disturbance, and after 2012, it was improved. Although the Study area of grassland was larger, but patch number was not, because in the whole study area grassland area occupies absolute advantage, showing distribution of concentration of contiguous, it is large, but patch number was relatively less. Irrigated was bigger than the patch area of dry land.MPS early was smaller. It increased gradually and steadily later, and the changes of it is stable, and the patch size of it is uniform. Mining of urban and rural residents with the patch density is very high. It explains that 1km^2 plaque number is large. Although the resident and industrial mining land area is not large, it is larger when

compared with plaque number. This reflects the expansion of construction land. Secondly, the patch density of dry farmland is relatively large, and the number of patches of dry farmland is large too. The density of patches in the water area is larger, which indicates that the water area is small, and the area of a single patch is small. The patch density of unused land decreased obviously. The density and size of patches, the human disturbance degree, and the shape of grassland patches are the most complex, and the human activities are relatively low, while the changes of the land, water, cultivated land are not obvious.

3.2 Landscape Level Index

The landscape level index of the study area is shown as Table 3, which reflects the change of the whole landscape pattern, and the number of patches increases and then decreases, while the largest patch index decreases. SHDI increased from 2006 to 2009, increased by18.4%, and then showed a slight increase, which indicates that the patch types in the initial stage of the study are not balanced, that is the proportion of each patch is larger, then gradually tends to equilibrium distribution. SHEI showed an increasing trend, which showed that the dominant patch area in the study area was gradually decreased, and the distribution of each patch in the landscape tended to be uniformed.

The CONTAG values decreased significantly, and the degree of aggregation decreased gradually during the study period, which reflects the increase of patch types, the dominance of various types of patches, and the connectivity changes.

Table 3. Landscape Indices of Landscape Level

Year	Number of patches(N P)	Largest patch index (LPI)	Shanon Diversity Index (S H D I)	Shanon Evenness Index (S H E I)	Landscape aggregation degree(CONTAG)
2006	5382	53.54	1.25	0.55	45.30
2009	6457	30.45	1.48	0.67	29．85
2012	7018	9.21	1.67	0.71	31.23
2015	6001	8.91	1.85	0.75	27.67

4. Summary

(1) On the whole, the grassland to agricultural landscape types in study area accounted for absolute advantage, followed by woodland, dry land first increased and then decreased, irrigated land increased gradually; whole grassland decreased gradually, which the high grass in increased and the middle and low grass decrease; the woodland overall decreased first and then increased, which has woodland, shrubbery decreased first and then increased, sparse forest and non forest continues to increase; integral water did not change significantly was weak fluctuation; urban and rural built-up land increased significantly; not use gradually reduced.

(2) From the perspective of landscape index, the number of patches increased, the average patch area decreased, the patch density was large and the fragmentation was obvious in the 2006 - 2009 years of the study area. The CONTAG index continued to decline, which showed that all types of patches in the landscape appeared in the spatial distribution, the SHDI and SHEI index showed that the fluctuation and the overall stability increased, reflecting the different types of agricultural landscape distribution and the increase of the landscape quality.

(3) The main reason for the change of agricultural landscape pattern in the study area is that the population is increasing, and the level of local economic development is limited, the demand of cultivated land is increased, and grassland, woodland, and beach are the first choice. Secondly, the national policy also plays a very important role in the early 80

's of the last century through the implementation of the family contract system, from the original national unified arrangements to farmers' spontaneous diversified business model. On the one hand, farmers get rich quick, excessive development, expand the planting area; on the other hand, diversified cropping exacerbated the landscape fragmentation.[7] Later because of the national land forest also grass policy influence and western big development strategy implementation, Ningxia in central arid with large-scale farmland also forest and grass project, natural forest protection project, greening of barren hills and wasteland, of slope cultivated land have the plan to have the step project also forest or grassland, forest and grassland area increased by a large margin, reduce greatly the area of cultivated land, unused land area reduce. To speed up infrastructure construction, strengthen the construction of infrastructure works, prompting the construction with the rapid expansion of the scale, irrigated area continued to grow.

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