ANALYSIS AND EVALUATION ON LANDSCAPE PATTERN OF SONGPAN COUNTY WITH REMOTE SENSING AND GIS

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ABSTRACT:

Satellite remotely sensed data has significant potential use in analysis and evaluation on Landscape Pattern. Relying on the recent advances in satellite remote sensing and geographic information system (GIS) techniques, this paper aims to probe into the analysis and evaluation on landscape pattern of Songpan county, which located in the north of Sichuan province, with RS and GIS. First, the geo-spatial remote sensing of study area was classified into six types using supervised classification method. Second, the landscape patterns and attribute data were picked up and systemically analyzed with GIS software and landscape analysis software. Finally, the landscape patterns were analyzed. And some results were got: (1) The irrigation woodland and natural turf occupy are utterly predominant in Songpan county. (2) The average shape index of the six types of patches is less than two, which indicates that the shape of patches is neat, and its nature zoology succession has been interfered by human beings. (3) Fragmentation values of the patches are between 0.0021 and 0.0288, indicating a common degree of fragmentation in Songpan County. (4) Landscape diversity index, max diversity index, landscape dominance index and landscape evenness index are used to analyze the whole landscape pattern in Sonpan County, and the result shows that the distribution of landscape pattern of the Songpan County is uneven and the degree of the whole diversity is low.

1. INTRODUCTION

One of the most rapidly growing applications of remotely sensed data is the derivation of landscape pattern metrics for the assessment of land cover condition and landscape change dynamics (Betts et al., 2003; Colombo et al., 2004; Egbert et al., 2002; Griffith et al., 2003; Hansen et al., 2001; Imbernon and Branthomme, 2001; Millington et al., 2003; Yu and Ng,2006; Santiago et al., 2007). Literatures have shown that Satellite remotely sensed data has significant potential use in analysis and evaluation on Landscape Pattern. Relying on the recent advances in satellite remote sensing and geographic information system (GIS) techniques (LI Jianping et al., 2007). Landscape pattern is generally referred to the spatial pattern of landscape, including types, numbers and spatial distribution and deployment of landscape unit. Landscape pattern is the essential performance of heterogeneity as well as the ecology process result on different scale (Chen Wenbo et al.,2002,). The aim of studying landscape pattern is to find the essential and significative rule on the landscape which seems to be out-of-order. By analyzing dynamic changes of landscape pattern and spatial relation of landscape patches, we can analyze amounts, location, type, shape, area, and direction of landscape structure; evaluate the macro, regional, and ecological environment and forecast future tendency; and reveal dominant factors and driving factors of formation and development of landscape pattern that will ultimately help promote landscape sustainability (LI Jianping., et al., 2007; Gulinck H., et al., 1993; Jianguo Wu,2006; Fanhua Kong, et al., 2007; Bell S S, et al., 1997). The landscape pattern analysis generally needs to describe and appraise the landscape structure by various quantitative methods to build up measurement moulds. At present, landscape ecology has been developed to be one set of ripe target system for measurement, description and statistics of landscape structure, from the qualitative analysis quantitative measurement, which lead to many landscape indices occurring. The landscape indices are used to describe and token the distribution status、spacing collocated relation and superiority between the landscape pattern, also can be used to describe and inspect the change of the character time for landscape structure. In this paper, remote sensing and geography information system methods are used to analyze the landscape pattern of Songpan County and the effect of main local eco-factors.

2. METHODOLOGY

2.1 Study area

Songpan County, which is located in the northwest of Sichuan Province, is the gateway to the Jiuzhai Valley fairyland, and also a part of the Aba autonomous region, lying between north latitude 32°45'-33°09' and east longitude 102°38'-104°15', Bordered on Pingwu county, Beichuan county in east, Nanping county in northeast, Maoxian county in south, Hongyuan county, Heishui county in southwest, Roerggai county in northwest.(see figure 1).

Nestling at the foot of the Minshan Mountain, and having the Minjiang River flowing past its gates, Songpan county has the characters of high and upright hypsography, piled ridges and peak, spreading gradually from dyke in southeast to grassland in northwest, which leading to the fancy physiognomy character and abundant grassplot sources. In area of alp and gorge, the

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opposite difference of height is to above 3000m, in addition to the affect of integrative natural complication, which result in various species and vegetation, and also well-regulated distribution for uprightness. But due to the lackness of water, most of them are mainly potato, corn, wheat and buckwheat; Between 2800m-3500m latitude, the sub-alp pin leaf forest that combined with spruce, fir and larch is main forest pattern in this area.

Figure 1 Location of study area.

2.2 Spatial data

LANDSAT ETM+ remotely sensed data on July 10th of 2002, with the land use map of songpan county in 1999, is used to retrieve landscape pattern in this paper. According to the relative factors of ETM+ wave band, the 1st band is affected by airing dispersion and the distinguish ratio of the sixth band is lower than others, they can not be used to analyze landscape pattern with the other bands, so only 2,3,4,5,7 bands are used. According to the coefficient indices analysis, the related degree of second and three wave band is quite high, and the coefficient index is above 0.9; The coefficient index between the fifth band and seventh band also around 0.9; The coefficient index between the fourth and other bands is much below 0.9, and only is around 0.3 in plain and wet vegetation area. Because Songpan county is mainly covered by vegetation, the 7,4,3 bands which are sensitive to vegetation are chosen to retrieve the landscape pattern.

2.3 Landscape patterns retrieving process

The main retrieving process (see Figure 2) is: first, ERDAS Imagine is adopted to classify landscape and evaluate the classification; second, ArcGIS is used to analyze the landscape pattern; then the landscape indices is retrieved by Fragstats. With these landscape indices, we can analyze the landscape pattern of Songpan county.
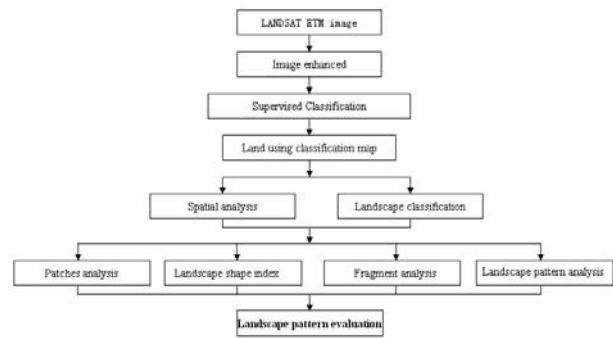

Figure 2. Technical process chart

3. RESULTS

3.1 Land use classification result

In order to get landscape classification map, the land use of study area was classified first. In this paper, the supervised classification was used. The Jeffries-Matusita distance between samples are all above 1.5, and the classification result's whole precision is 86.74% with kappa coefficient of 0.8351. Figure 3 is the land use classification map of Songpan county.
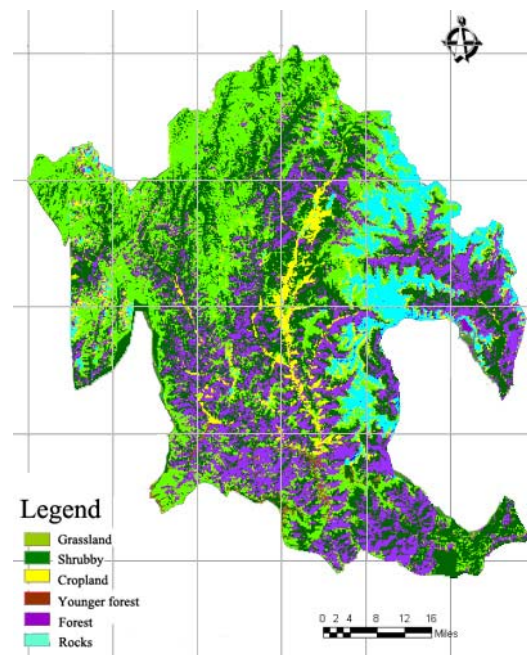

Figure 3 Land use map of Songpan County.

3.2 Landscape map in study area

The classification of landscape ecology can depart the landscape ecological system from the function and structure. It is the deepening direction of the earth classification; also it is the important new element of the ecological research. There are so many points of views to the landscape classification due to the different understanding of landscape. Westhoff classifies the landscape into nature landscape, sub-nature landscape, half-nature landscape and agriculture landscape, according to the characters of the earth and plant that reflect landscape's nature

degree. While Z.Naveh classifies the landscape into nature landscape, half-nature landscape, half-agriculture landscape, agriculture landscape, countryside landscape, rural landscape and urban landscape according to the energy, matter and information of landscape. Chinese geography academic area has done a lot of research on land use type, they define the land use type as "a nature complex which formed by mutual roles of the ground surface environment geographical elements." In fact, this is quit relevant to the landscape type classification. However, due to the transformation of the earth apply/earth cover is mainly affected by human's activities, the nature and half-nature landscape constantly is changed into the artificial management fields and industrialized cities. Therefore, the traditional classification of land use can not totally reflect the really different landscape types because it only take the nature property of land into account with little concerning of the land changing situation created by human activities (Xu Hui, et al., 1993).

The land use type refers to the method to use a land cover in human society. The combination of different land use methods forms different landscape and landscape pattern. Actually, the process of land use is the process that nature landscape transforms to human landscape. The land use and land cover are composed of different types of patches, and, the spatial distribution of these patches forms the landscape pattern. Therefore, we can get the landscape classification map from the land use classification map in ArcGIS, shown as figure 4.

From figure 4, we can see the grassland is mainly located in the northwest part of the study area, the most part of the forest islying on the southeast part of the study area. In the middle of the study area, there is sporadically distributed by some ceopland and younger forest. The rocks are located in the edge of the research area, extending from the edge to the center. When comparing in area, the biggest is the shrubby, the least is the younger forest, while the cropland is bigger than the rocks but is less than the forest.

3.3 Landscape pattern analysis

3.3.1 Landscape patch analysis: Landscape patch, as the base of landscape pattern, can be described by the number of landscape patterns, the quantity of each pattern, the area of each pattern, the average area of patch, the coefficient of area variation for patch, standard difference of area, max patch index and so on. These characters can reflect the status of landscape pattern in a quantitative way. Table 1 is the statistics of study area.

From the table, we can see that the whole area of study area is 759588.4647hm2, therein the area of grassland is 238955.6512hm2，which occupy 31.67% of the whole study area; The shrubby area is 256613.8758hm2，which occupies 33.82% of the whole study area; The cropland area is 30303.7918hm2, which occupies 4.10% of the whole study area; The forest area is 167553.7659hm2，which occupies 22.08% of the whole study area; The younger forest area is 3360.7589hm2，which occupy 0.43% of the whole study area; The rocks area is 62800.6211hm2，which occupies 8.25% of the whole study area. This shows that the shrubby's proportion is the biggest, next are grassland, forest, rocks and cropland, the younger forest has the lowest proportion.
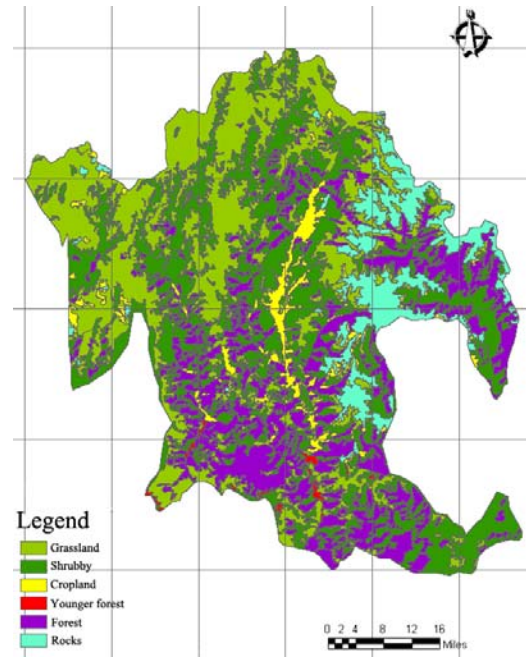

Figure 4 Landscape Map of Songpan County.

Landscape pattern	Number (pieces)	Area(hm^2)	Average area(hm^2)	coefficient of area variation	max patch index(%)
Grassland	169	238955. 6512	116973. 9388	904. 0407	21. 92
Shrubby	219	256613. 8758	47122. 3355	626. 2208	13. 55
Cropland	96	30303. 7918	5785. 6061	416. 2732	1. 71
Forest	171	167553. 7659	14435. 3103	370. 5700	4. 64
Younger forest	16	3360. 7589	380. 3904	90. 0541	0. 09
Rocks	26	62800. 6211	17578. 4390	250. 5519	3. 63
total	697	759588. 4647	-------	-------	-------

Table 1 the statistic value for the patches in study area.

When comparing the number of patches, we can see that the number of shrubby is the most, which reaches to 219 pieces, following by forest of 171 pieces, grassland of 169 pieces, cropland of 96 pieces, rocks of 26 pieces and younger forest of 16 pieces. But for the average patch area of each landscape pattern, the least is the younger forest, which is 380.3904hm2,following by cropland, forest, rocks, shrubby and grassland. The number and average area of patches can reflect the fragmentation of a certain landscape pattern in some degree.

The coefficient of area variation is the proportion of the standard difference of patch area to average patch area. From table 1, we can see that younger forest has the least coefficient of area variation, following by rocks, forest, cropland, shrubby and grassland. The max patch index is that the proportion of the max patch area to the max area of a landscape pattern. The max patch index of the grassland reaches to 21.92%, which explains that the distribution of grassland is seriously unbalanced. Following are shrubby, forest, rocks, cropland and younger

forest，and the max patch index of younger forest is the least, which only to be 0.09%.

3.3.2   Patch shape index analysis: The shape index of patch is generally the proportion of the width of a patch to the area of the patch. There are several shape indices. In this paper, two shape indices were calculated(shown as table 2).

Landscape pattern	Proportion of perimeter to area	Average patch shape index
Grassland	50.3336	1.0492
Shrubby	50.2335	1.0533
Cropland	53.5679	1.0440
Forest	47.6448	1.0522
Younger forest	51.0604	1.0455
Rocks	38.3738	1.0646

Table 2 the average patch shape index for the landscape patterns of study area.

If the proportion of perimeter to area is larger, the boundary value patch is larger, and the intensity of fringed effect also is larger and otherwise. From table 2, we can see that the largest proportion of perimeter to area is cropland, following by younger forest, grassland, shrubby, forest and rocks. The average patch shape index of all patterns is below 2, the largest is rocks and the least is the cropland, this shows that the patch shape in this area is regular, so the landscape patterns are affected by human activity in some degree (the most is the cropland and the least is the rocks).

3.3.3   Fragmentation analysis: Fragmentation of landscape is the process that the landscape changes from simple to complex due to the natural and artificial factors. There are many indices to describe fragmentation. In this paper, average area, fractal dimension, departure and density of patches are used to analyze the fragmentation of the landscape in study area (shown as table 3).

Landscape pattern	Average fractal dimension	Density of patches	Departure (%)
Grassland	1.0492	0.0222	2.37
Shrubby	1.0533	0.0288	2.51
Cropland	1.0440	0.0126	13.66
Forest	1.0522	0.0225	3.40
Younger forest	1.0445	0.0021	53.49
Rocks	1.1895	0.0034	3.52

Table 3 Statistic of fragmentation for landscape pattern in study area.

Generally speaking, for a patch, the larger the degree of human activity, the simpler the geometry shape of the patch, leading to more linear boundary, so the lower the fractal dimension of the patch and vise versa. The fractal dimension of patch for landscape pattern in study area is between 1.0445 and 1.1895, which lies in former half segment of 1 to 2, this indicates that boundary of the patches is simple and the geometry shape of the

patches is comparatively quite regular, so the disturbance of human is comparatively quite large.

The least density of patches of the six landscape patterns in study area is younger forest, following are rocks, cropland, grassland, forest and shrubby. This is due to that the area of younger forest is small and the number of patches is little, so it has the least density of patches.

The departures of the six landscape patterns are quite different, which reflects the affection of human activity on landscape in some degree. The largest departure is 53.49, for younger forest, following is cropland and the least is the grassland. This is because that the younger forest scattered in all directions of study area, its departure is large, the cropland disperse along rivers like a strap, so its departure also is quite large. while the number of shrubby patches is quite, so its departure is quite small.

3.3.4   Landscape pattern analysis: The landscape diversity index, landscape dominant degree and landscape even degree and other eigenvalues are used to analyze landscape pattern (shown as table 4).

Target	Eigenvalue
Total area	759588.4647hm^2
Number of patches	697
Average patch area	1089. 7969hm^2
Diversity index	1. 4224
Even degree	0. 7939
Max diversity index	1. 7917
Dominant degree	0. 3881

Table 4 eigenvalues for landscape pattern in study area.

From table 4, we can see that the diversity index is 1.4224, having 0.3693 gap to the max diversity index of 1.7917, this indicates that the whole diversity of landscape of study area is medium, the ratio is quite different among all the landscape patterns. And the dominant degree is 0.3881 and the even degree is 0.7939, this also indicates that the landscape patterns distributed asymmetrically and some landscape pattern have more area than other landscape patterns.

3.4 Landscape pattern evaluation in study area

Form the analysis above, we can see that the landscape pattern is mainly asymmetrical, with low diversity, the grassland and shrubby are the dominant landscape pattern in study area. The departures of the landscape patterns in study area are around 0.1 except the younger forest, this indicates that the self connection of each landscape pattern in study area is quite strong, while the departure of the younger forest reaches to 0.4630, which explains that human activities have a strong influence on landscape pattern. The cropland disperses in the long and narrow belt along the transportation line, the densest area in Songpan county，this also indicates human activities have much influence on landscape pattern.

4. CONCLUSION & DISCUSSION

With RS and GIS technology, this paper analyzes and investigates the landscape pattern in study area, hoping that it will have a detailed view on the landscape pattern in study area and provide some new methods and ideas for the landscape protection. The significance of this paper lies in follows:

- ERDAS IMAGINE was used to enhance and classify the ETM data to get a primary land-use classification map , this land use map conforms well to the land use map in 1999, then ArcGIS was used to retrieve the landscape map in study area and Fragstats was used to calculate some landscape indices to evaluate the landscape pattern in study area.
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- The dominant landscape patterns in study area are grassland and shrubby, but with rocks of 8.25%; all the six landscape patterns have an average fractal dimension about 1.0400, which mean that all landscape patches' shapes is not complex, so human activity disturbes the landscape pattern to some degree; The density of patches for all landscape patterns are between 0.0021 and 0.0288, this means that the degree of fragmentation is quite small; the average diversity index is 1.4224, which has 0.3693 gap to the average max diversity index of 1.7917, this result shows that the diversity of landscape pattern in study area stays at a medium level, so the ratios of the landscape patterns is quite different.
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- The diversity, even and fragmentation of the landscape pattern in study area is augmented along with the strengthened level of land use and development, but the superiority of landscape pattern is opposites, this urged us that we should protect our eco-environment when developing economy.

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