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A STUDY ON LANDSCAPE MOSAIC STRUCTURE IN URBAN-RURAL AREA IN NORTHWEST OF CHINA WITH RS AND GIS
—A Case Study of Xigu District in Lanzhou City

XU Jian-hua[1], LU Yan[1], AI Nan-shan[2], YUE Wen-ze[3]

(1. Department of Geography, East China Normal University, Shanghai 200062, P. R. China;
2. Environmental Science and Engineering School, Sichuan University, Chengdu 610064, P. R. China;
3. Department of Geography, Lanzhou University, Lanzhou 730000, P. R. China)

ABSTRACT: At the study area of Xigu District in Lanzhou City, using RS & GIS as tools we apply Diversity, Dominance, Fragmentation , Isolation and so on to study the quantitative, fractal and spatial characters of landscapes` structures in the four sub-regions divided by the morphological features. Using the Fractal Theory to establish the fractal structure models, we analyze the complexity and stability of various landscapes` distribution with fractal dimension value. The spatial distribution characteristics of landscape mosaic structure are also expounded. At the end of the paper we discuss the relevant problems on the main factors which control and effect on the spatial pattern of landscapes as well as on landscape optimization and management.

KEY WORDS: landscape mosaic; spatial structure; fractal; Xigu District in Lanzhou City

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1 REGIONAL BACKGROUND AND RESEARCH METHODS

1.1 Regional Background

In Lanzhou City, Xigu District, which covers an area of 103°19′48″ – 103° 41′02″ E and 35°38′16″ – 36°13′57″N, is located at the upper Huanghe(Yellow) River and middle part of Gansu Province. It is an industrial-agricultural, urban-rural county level administrative region with an area of 362.98km^2.

The Huanghe River, which goes through it from west to east, divides the whole district into two parts. The Huangshui River, the Zhuanglang River and the Xianshui River respectively flow into the Huanghe River in the west and north of the region. The whole geomorphology of the region is that north is much lower than south, but both are higher than the middle valley (Fig. 1). According to geomorphological characters, the whole district is divided into four sub-regions. 1) The river valley area with an altitude of 1528 – 1600m is located at the 1st and 2nd fluvial terraces by the Huanghe River and the Huangshui River. It has an area of 7386ha, accounting for 19.8% of the whole

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Biography: XU Jian-hua(1965 –), male, a native of Gansu province, professor. His research interest includes Geo-computation and GIS.

district, and it is also the center of regional economy, society and culture. 2) The terrace & gentle slope area, located at the 4th and 5th terraces of two banks of the Huanghe River, with an area of 4401ha, which accounts for 11.8% of the whole district, is mainly composed of eight terraces with an altitude of 1607 – 1800m and a slope of less than 10°, namely Dajia terrace, Zhangjia terrace, Qingshi terrace, Zhama terrace, Liugou terrace, Fanjia terrace, Zhangjia terrace, Guangjia terrace, etc. 3) The southern mountainous area is located above the southern terraces, with an altitude of 1800 – 2621.4m and an area of 9588ha, accounting for 25.6% of the whole district. 4) The northern mountainous area is located above the northern terraces of the Huanghe River, with an altitude of 1600 – 2064.6m and an area of 16 001ha, accounting for 42.8% of the whole district.

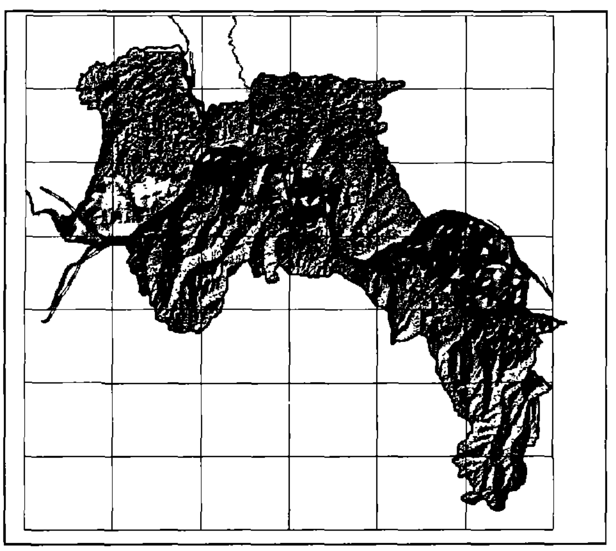

Fig. 1 The digital elevation model of Xigu District in Lanzhou City

Xigu District is typically continental and semi-arid climate and has obvious vertical climate change. Average daily temperature difference and annual average temperature are respectively 13.6℃ and 8.5℃, extreme high temperature 39.7℃ and extreme lower temperature −23.4℃. And the change rate of rainfall and distinct spatial discrepancy are much larger. Annual rainfall gradually decreases from 500mm in the southeast mountainous area to 291mm in the northwest mountainous area.

1.2 Data and Research Method

All the data needed include 1) 1∶8000 aerial remote sensing image data(1998), 2) 1∶50 000 TM image data(2000), 3) 1∶10 000 relief map(1998), 4) other data including climate, hydrology, vegetation, soil and so on.

The research method consists of six major steps: 1) use 1∶50 000TM image to interpret and classify the landscapes, 2) select 1∶8000 aerial remote sensing image and 1∶10 000 relief map to make a survey of land cover/land use and landscape patches, 3) digitize images and relief map data(remote sensing image, relief map, survey data and so on), 4) integrate data into a GIS system by image calibration, registration and data processing for building spatial and attribute databases, 5) apply the quantitative methods to the quantitative characteristics of the landscape mosaic structure and fractal theory to fractal characteristics of the distribution pattern of various landscapes, 6) with spatial analytical methods of GIS(DENESH, 1995), study the main factors which control and influence the spatial pattern of landscapes. Various methods and techniques used in this study are briefly described in Fig. 2.

2 LANDSCAPE MOSAIC AND QUANTITATIVE CHARACTERISTICS

In a region, various landscape patches integrate systematically into a landscape mosaic(FORMAN *et al.*, 1986), which shows spatial pattern of landscapes and is the result of the natural factors and human activities. Some scholars think that the essence of landscape ecology is to study the landscape mosaic structure in that landscapes are diverse mosaic entities(FORMAN, 1995; XIAO, 1991).

2.1 Landscape Types and Mosaic Map

By TM interpretation we classify the landscapes into ten kinds of landscapes, which are respectively

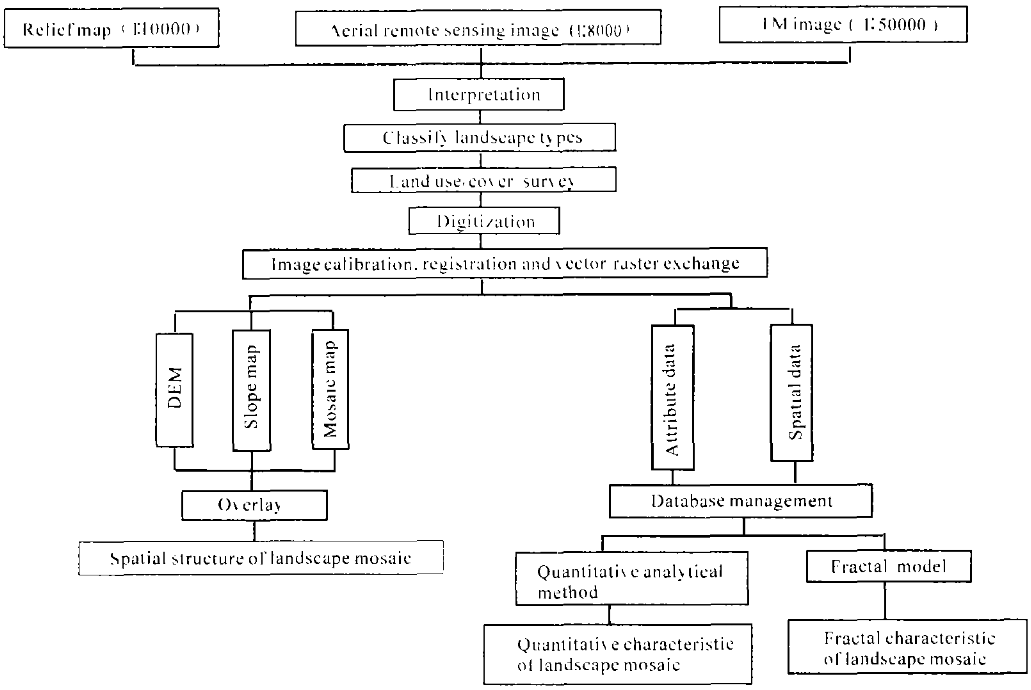

Fig. 2 Research methods and techniques

farmland, orchard, woodland, scattered woodland, bare land, water area, urban area, rural settlement and industrial area far from settlement. The special meaning of each landscape is listed in Table 1.

In order to show and analyze the spatial structure of landscape mosaic, we made the landscape mosaic map of Xigu District in Lanzhou City from the spatial and attribute databases of GIS, which is shown in Fig. 3.

Table 1 Landscape types and remarks

Landscape types	Remarks
Farmland	Covered by crops and vegetation
Orchard	Including apple orchard, peach orchard, pear orchard, apricot orchard, etc.
Grassland	Wasteland, pasture
Woodland	Natural and artificial woodlands with canopy of trees larger than 30%
Scattered woodland	Woodland with canopy between 10% - 30% of area and newly-made woodland with no canopy but viable rate no less than 40% of reasonable tree numbers
Bare land	Land without vegetation coverage, including bare loess, rock and gravel
Water area	Including river, creek, alluvial flat and pond
Urban area	Including satellite towns and the built-up area in the region planned by City Planning
Rural settlement	Rural residential area
Industrial area far from settlement	Including various factories and plants, which are far from settlement and not in the urban area

2.2 The Quantitative Characteristics of Landscape Mosaic

2.2.1 *General quantitative characteristics of landscape mosaic*

we can use diversity, dominance and fragmentation to comprehensively quantify the landscape mosaic structure.

1) Diversity, which is a general description of abundance and balance of landscapes (TURNER *et al.*, 1991; ZHANG *et al.*, 2000), is defined as follows:

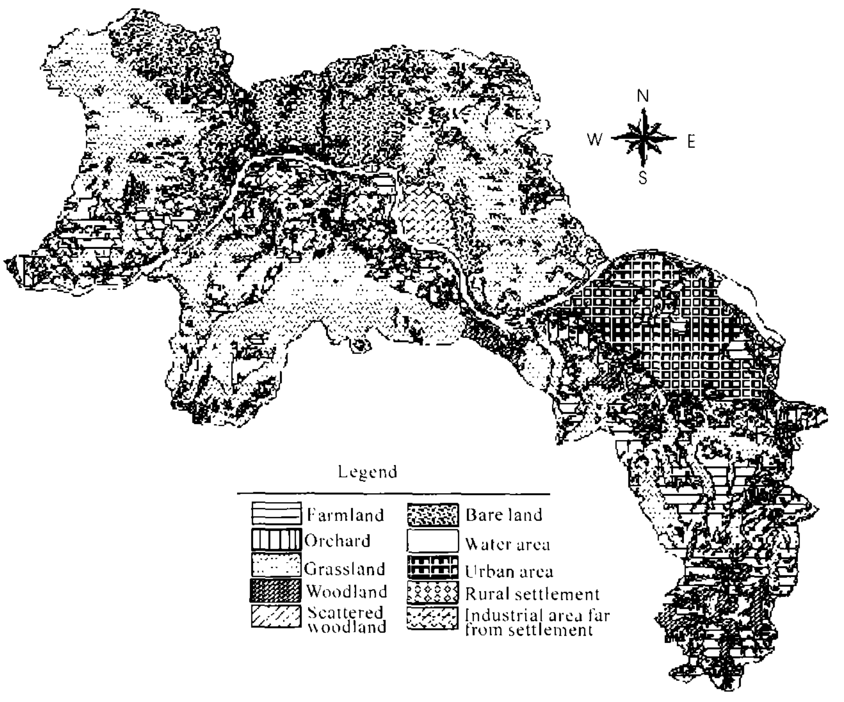

Fig. 3 Landscape mosaic map of Xigu District

$$H = -\sum_{i=1}^{S} P_i \ln P_i \quad (1)$$

In formula (1), S is the number of landscape types; P_i is the area percent of landscape type i in the whole mosaic; H is diversity index, which is much larger, the more abundant landscapes

2) Dominance is an indictor that shows what extent one or few landscapes dominate in mosaic structure, and it is defined as follows:

$$D = \ln S + \sum_{i=1}^{S} P_i \ln P_i \quad (2)$$

where D represents dominance, which is much larger, the more highly mosaic structure is dominated by one or few landscapes; S and P_i are as same as those in formula (1).

3) Fragmentation is used to show the number of patches in one unit area in the mosaic, and it is defined as follows:

$$F = \sum_{k=1}^{S} n_k / A \quad (3)$$

In formula (3), S is as same as that in formula (1); n_k is the patches' number of landscape type k; A is the whole area of all types of landscapes; F is fragmentation, which is much larger, the more patches are in a unit area.

We use formulas (1), (2) and (3) to calculate diversity, dominance and fragmentation as the following in Table 2.

Table 2 shows that diversity ranks in the four sub-regions as river valley area(2.0375)> terrace &

Table 2 Landscape diversity index, dominance and fragmentation in sub-regions

Area	River valley area	Terrace & gentle slope area	Southern mountainous area	Norhtern mountainous area	The whole district
Diversity(H)	2.0357	1.8544	1.3080	1.2395	1.827
Dominance(D)	0.2669	0.4482	0.9987	1.1584	0.658
Fragmentation(F) (patches/km^2)	27.4772	51.4398	9.4733	8.3118	12.147

gentle slope area(1.8544)> southern mountainous area (1.3080)> northern mountainous area(1.2395), but there is an adverse rank in terms of dominance, namely northern mountainous area(1.1584)> southern mountainous area(0.9987)> terrace & gentle slope area (0.4482)> river valley area (0.2669). Obviously in the river valley area various landscapes are distributed equably without distinct dominant landscape types. But in the southern mountainous area and northern mountainous area they are distributed extremely unevenly and there are obvious dominant landscapes. In the northern mountainous area, the dominant landscape is grassland, which comprises of 85.96% of the whole area. In the southern mountainous area, the dominant landscapes are grassland and farmland, which respectively account for 60.93% and 28.51% of the whole area. And diversity and dominance in the terrace & gentle slope area are between those in the river valley area and those in the south and northern mountainous areas.

Fragmentation represents what extent the landscapes are cut by various corridors(creeks, roads and etc.). The larger fragmentation, the more strongly landscapes are cut by corridors. Obviously the fragmentation of terrace & gentle slope area is the largest and the patches with an area of $1km^2$ are as many as above 51.4398, and the fragmentation of the river valley area is much larger, 27.4772 patches with an area of $1km^2$. But in the south and northern mountainous area the fragmentations are small, respectively 9.4733 and 8.3118 patches with an area of $1km^2$.

2.2.2 Landscape isolation

Isolation shows that the distribution of different patches that belong to the same type of landscape in the landscape mosaic. It is defined as the follows(XIAO, 1991):

$$I_k = \frac{1}{2}\sqrt{\frac{n_k}{A}} \Big/ \frac{A_k}{A} \tag{4}$$

where I_k is the isolation of landscape type k, n_k and A are as same as those in formula(3), A_k is the area of landscape type k.

For the same type landscape, isolation shows that what extent the landscape is cut and isolated by other landscapes or corridors. That is, the larger the isolation is, the more dispersedly the patches distribute.

As for the four sub-regions in this region, we apply formula(4) to figure out the isolation of various landscapes listed in Table 3.

Table 3 shows that farmland is most densely distributed in the river valley area and terrace & gentle slope area, more densely in the southern mountains, but in the northern mountainous area it is distributed more dispersedly. Orchard mostly is compactly distributed in the terrace & gentle slope area, more compactly in the river valley area, however it is distributed more dispersedly in the south and northern mountainous areas. Grassland is more sparsely distributed in the terrace & gentle slope area, more densely in the southern mountainous area, but it is distributed most densely in the northern mountainous area. Woodland (including woodland and scattered woodland) hardly exists in the northern mountainous area and is sparsely distributed in the river valley area and level & gentle slope area, but most densely distributed in the southern mountainous area. Bare land is most densely distributed

Table 3 Isolation of various landscapes in sub-regions

Area	Famland	Orchard	Grassland	Woodland	Scattered woodland	Bare land	Water area	Urban area	Rural settlement	Industrial area far from settlement
River valley area	6.1682	12.3953	7.942	51.2730	36.5440	11.0947	3.8840	0.2244	13.1183	5.9180
Terrace & gentle slope area	6.2548	8.4266	7.1522	44.1453	23.9741	29.2099	-	10.4207	12.4217	17.1712
Southern mountainous area	9.5215	28.8777	3.8371	9.9431	14.4415	38.7253	-	-	21.0350	-
Northern mountainous area	13.3231	21.7048	1.4431	-	-	1.3171	-	-	22.8955	-

in the northern mountainous area, more densely in the river valley area, but more sparsely in the terrace & gentle slope area, most sparsely in the southern mountainous area. Urban area is mainly located at the river valley area and level gentle slope area, more densely at the river valley area, but more sparsely at the terrace & gentle slope area. Rural settlement is distributed in all the four sub-regions, most densely in the terrace & gentle slope area, more densely in the river valley area and more sparsely in the southern mountainous area, but most sparsely in the northern mountainous area. Industrial area far from settlements is mainly distributed in the river valley area and terrace & gentle slope area, more densely in the river valley area, but more sparsely in the terrace & gentle slope area. All the water area is distributed in the river valley area.

3 THE FRACTAL CHARACTERISTICS OF LANDSCAPE MOSAIC

Research findings show that landscape mosaic is the most typically fractal entity in nature(BAI, 2000; XU *et al.*, 2000), and various landscapes can be quantified by the fractal theory. MANDELBROT(1982) studied the structures of fractal entities and put forth a model:

$$[S(r)]^{\frac{1}{D}} \sim [V(r)]^{\frac{1}{3}} \qquad (5)$$

where $S(r)$ is surface area, $V(r)$ is volume, r is measurement scale, D is fractal dimension. DONG Lian-ke used formula (5) to build the fractal structure model which is for n dimensions Euclid space as the below formula(DONG, 1991):

$$[S(r)]^{\frac{1}{D_{n-1}}} = kr^{(n-1-D_{n-1})/D_{n-1}}[V(r)]^{\frac{1}{n}} \qquad (6)$$

Taking $n = 2$, we get the fractal structure model in 2-dimension Euclid space:

$$[P(r)]^{1/D_1} = kr^{(1-D_1)/D_1}[A(r)]^{1/2} \qquad (7)$$

where $P(r)$ is circumference; $A(r)$ is area; k is constant; D_1 is fractal dimension in 2-dimension Euclid space.

As for a landscape patch, are its area and circumference suitable for the formula(7)? That is, has landscape shape the fractal characteristic? Related research showed that any type landscape has the fractal characteristics(BAI, 2000; XU *et al.*, 2000).

Taking the formula(7) logarithmic transformation, we obtain:

$$\ln[A(r)] = \frac{2}{D_1}\ln[P(r)] + C \qquad (8)$$

It is obvious that as long as we establish the regressive model like formula(8) with the area and circumference of the patch, we can get regressive coefficient $2/D_1$ and D_1., where D_1 represents the complexity and stability of landscape type. The larger D_1, the more complicated the landscape type is. When D_1 is equal to 1.50, the landscape type is in the state of probability similar to Brown movement, which is in the most unstable state. The more closer D_1 is to 1.5, the more unstable the landscape type is(PEARCE, 1992; ZHAO *et al.*, 1995). According to the steps mentioned above, we establish the fractal structure models of various landscapes and get their dimensions(Table 4).

1) According to complexity(D_1), various land-

Table 4 The fractal models and dimensions of different types of landscape

Landscape type	Fractal model(regression equation)	Fractal dimension(D_1)	Sample number(n)	Correlation(R^2)
Farmland	$\ln A(r) = 1.6247\ln P(r) - 1.1668$	1.2310	1231	0.9352
Orchard	$\ln A(r) = 1.566\ln P(r) - 0.7431$	1.2771	707	0.9535
Grassland	$\ln A(r) = 1.7264\ln P(r) - 2.1339$	1.1585	1041	0.9267
Woodland	$\ln A(r) = 1.5\ln P(r) - 0.3928$	1.3333	169	0.9293
Scattered	$\ln A(r) = 1.5731\ln P(r) - 0.8164$	1.2714	119	0.9115
woodland	$\ln A(r) = 1.5902\ln P(r) - 1.0455$	1.2577	212	0.9304
Bare land	$\ln A(r) = 1.49\ln P(r) - 0.7539$	1.3423	160	0.9244
Water area	$\ln A(r) = 1.8102\ln P(r) - 2.9351$	1.1049	54	0.9159
Urban area	$\ln A(r) = 1.6099\ln P(r) - 1.0011$	1.2423	400	0.9589
Rural Settlement	$\ln A(r) = 1.6247\ln P(r) - 1.1668$	1.0793	283	0.9355
Industrial area far from settlement	$\ln A(r) = 1.8531\ln P(r) - 2.3133$			

scapes are ranked as follows: water area (1.3423)> woodland (1.3333)> orchard (1.2771)> scattered woodland (1.2714)> bare land (1.2577)> rural settlement (1.2423)> farmland (1.2310)> grassland (1.1585)> urban area(1.1049)> industrial area far from settlement(1.0793), but if they are ranked in the terms of stability, the conclusion is just adverse.

2) Water area is the most unstable landscape because Xigu District is located in the transitional region of three natural regions, and it is very complicated as a result of effects of unstable rainfall and surface water supplies.

3) That the dimension of woodland landscape is approximate to that of water landscape shows that they are similar in the complexity and stability as well as distribution pattern. The reason is that there are no large-scale wood-planted conditions and even small-scale woodland is also based on the water supplies.

4) The complexity of scattered woodland is less than that of woodland and its stability is very weak, because scattered woodland is mainly artificial, and due to the difficulty and hard conditions of planting trees in the region.

5) The complexity of farmland is higher than that of grassland, but has a weaker stability. This can be explained that although the distribution pattern of artificial farmland is more complicated than that of natural grassland, its stability is weaker than grassland's stability.

6) The complexity of rural settlement is higher than those of urban area and industrial area far from settlement, but lower in stability. Thus it is proved that rural settlement is lack in planning and there exist serious irrational approvals and construction.

4 ANALYSIS ON SPATIAL STRUCTURE OF LANDSCAPE MOSAIC

4.1 Slope Analysis

The distribution characteristics of landscapes at different slopes in Xigu District of Lanzhou City are shown in Fig. 4. Above 80% of water area, urban area and industrial area far from settlement and above 30% of farmland, orchard, scattered woodland and rural settlement are distributed in the area with a slope of 0 – 2°. Among those landscapes, water area is mainly the Huanghe River and the rest are direct results of human activities. Then it is indicated that the area, which is the most suitable for human production and living, is most intensively affected by human activity. Seventy percent of grassland, woodland and bare land as well as 30% of farmland are distributed in the area with a slope of 25 – 90°. It shows that landscapes affected less intensely by human activities are just in the area with steeper slope, so the conclusion can be made that the structure of land use is not rational in the region. In the area with a slope of 2 – 6°, orchard, rural settlement, water area and scattered woodland cover a larger area. In the area with a slope of 6 – 15°, orchard, rural settlement and scattered woodland are distributd widely. In the area with a slope of 15 – 25° there is mainly farmland.

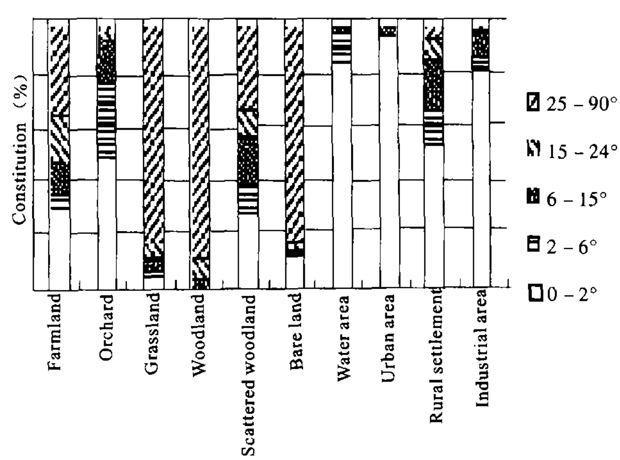

Fig. 4 Constitution of landscapes at different slopes in Xigu District

From Table 5, we can see that most of landscapes are distributd in the area with a larger slope, and patches with a slope of above 25° account for 50.9% of all the patches. The number of patches is the maximum in the area with a slope of 0 – 2° and the minimum in the area with a slope of 2 – 6°. The number of patches increase with the slope from 2° to 90°, but diversity decrease with the slope. Dominance in a slope of 0 – 2° is higher and increases with the slope as urban landscape is made from several larger and continuous

Table 5 Quantitative characteristics of landscape mosaic structure in different slope area

Slope	Area(ha)	Patch number	Diversity index(H)	Dominance(D)	Fragmentation(F)
0 - 2°	11966.3	3288	2.036	6.062	27.477
2 - 6°	1462.5	611	1.828	4.587	41.777
6 - 15°	2088.4	1217	1.779	5.325	58.275
15 - 25°	2303.8	1297	1.323	5.845	56.299
25 - 90°	18477.3	1355	1.026	6.186	7.333

patches. The fragmentation is the smallest in the area with a slope of 25 - 90°, because grassland, bare land and woodland are distributed here continuously. In the slopes of 6 - 15° and 15 - 25°, the fragmentation is the largest since there are so many small patches.

4.2 Altitude Analysis

Statistical results of landscapes located at different altitudes show that above 80% of water area, urban area and industrial area far from settlement and above 40% of orchard and rural settlement is distributed in the area with an altitude below 1600m. There are also above 50% of orchard, grassland, scattered woodland and bare land that are located in the area with an altitude of 1600 - 1800m. In the area with an altitude of 1800 - 2000m grassland and farmland are widely distributed, which account for above 20% of the whole region. Above 60% of grassland and 40% of farmland are distributed in the area with an altitude of above 2000m. The quantitative characteristics of landscapes at different altitudes are shown in Table 6. In the area with an altitude of 1600 - 1800m, the area of each landscape is the largest and the number of patches is the maximum. Diversity(H) begins to increase and ends to decrease with the altitude. Dominance is the strongest in the area with an altitude of 1600 - 1800m and the weakest below 1600m. Fragmentation in the area with an altitude above 2000m is the largest and much larger below 1600m. Except for area and dominance, other three dictators are the smallest in the area with an altitude of 1800 - 2000m. The reason is that the area with an altitude below 1800m has a gentle slope and is affected intensely by human activities, so diversity and fragmentation are much larger and accordingly dominance is much smaller. That human consciously improve natural conditions such as artificial irrigation projects also contribute to enrich landscapes. Rainfall, landscape diversity and fragmentation obviously increase in the area with an altitude above 2000m because of vertical zone law. However, in the area with an altitude of 1800 - 2000m, the number of landscape types is the smallest and consequently dominance is the largest because of less influence of human activities.

4.3 Comprehensive Analysis of Slope and Altitude

Fig. 5 shows that most landscapes are distributed at a relatively small area and above 40% of patches concentrates in the area with a slope of 0 - 2°, about 65% of patches at an altitude below 1800m, 25% of patches are located at the 1st and 2nd terraces of the Huanghe River, namely the river valley area and 40% of patches at the 4th and 5th terraces, namely terrace & gentle slope area. Generally distribution frequency of most types of landscapes is higher in the area with low altitude and gentle slope. Accordingly frequency is lower in the area with higher altitude and steeper slope. But woodland landscape is an exception, which is mostly distributed in the southern mountainous area with higher altitude and steeper slope.

5 THE MAIN FACTORS AFFECTING AND CONTROLLING LANDSCAPE SPATIAL PATTERN

Using the spatial analytical functions(Overlay, Buffer and so on), we find that the regional landscape pattern is mainly affected and controlled by climatic conditions, river corridor, topographical pattern and human activities.

Table 6 Quantitative characteristics of landscape mosaic structure in different altitudes area

Altitude(m)	Area (ha)	Patch number (P)	Diversity(H)	Dominance(D)	Fragmentation(patches/km^2)
<1600m	8423.66	1078	1.978	5.005	12.797
1600 - 1800m	16242.31	1811	1.305	6.197	11.150
1800 - 2000m	6390.51	543	0.784	5.514	8.497
> 2000m	5241.97	786	1.177	5.490	14.994

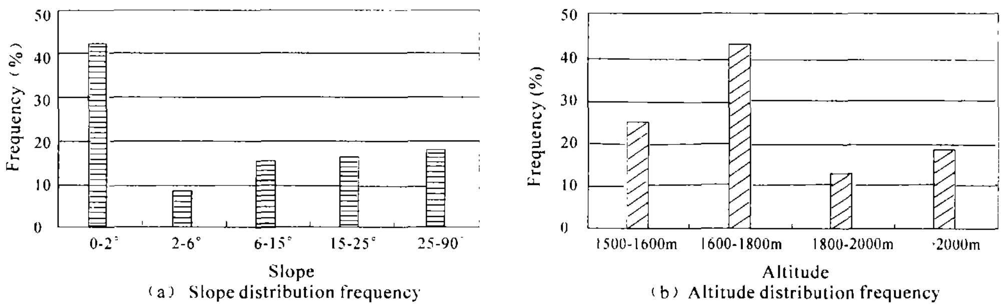

Fig. 5 The distribution frequencies of landscapes at different slopes and altitudes

5. 1 Climate

From the macro-regional background, Xigu District is located at the transitional region of the three climatic regions, namely eastern monsoon region, northwestern arid region and the Tibet Plateau region. And this district has a typical characteristic of continental and semiarid climate. The natural landscape formed in the climatic conditions is semi-arid grassland(FANG, 1994), so grassland is a dominant landscape in the whole district. Within the district the spatial differences of climatic conditions are very distinct, especially vertical climate changes in the mountainous areas. In the northern mountainous area there is enough sunlight and intensive evaporation, but sparse rainfall(290 - 320mm/a), where it is very difficult to cultivate the farmland by natural rainfall. So farmland only makes up of 2.81% of the whole district and is mostly(above 60%) irrigation land depending on lift irrigation from the Huanghe River. In the southeast Guanshan mountainous area temperature is relatively low, but annual rainfall is as much as above 500mm. So there are some forests in the shade hillsides of mountains, and the dominant sort of species is spruce. Sixty percent of woodland in the whole district concentrates here.

5. 2 River Corridor and Landform

The regional landscape spatial pattern is absolutely controlled by river corridors and landform, by whose effects the four sub-regions are formed, namely the river valley area, the terrace & gentle slope area, the southern mountainous area and the northern mountainous area. This objectively shows the spatial pattern of landscape. The river valley area naturally becomes the center of human activities because of its flat land, convenient traffic and closer to water resources, so various landscape patches are distributed evenly in the area and landscape diversity index is large and dominance is weak. In the terrace & gentle slope area due to platter land, relatively lower altitude and more convenient irrigation conditions, obviously there concentrate farmland, orchard and rural settlement. In the southern mountainous area and northern mountainous area, on account of the effects of steeper slope , higher altitude and of being far away from water resources, their landscape types are not so many as those of the two forenamed areas. Landscape diversity is smaller and dominance is stronger. In the northern mountainous area dominates and intensely distributes grassland, but arid farmland, grassland and woodland in the southern mountains.

5. 3 Human Activities and Traffic Corridors

All the landscapes in the district are affected or being interrupted to some extent by human activities, among which farmland, orchard, urban area, rural settlement and industrial area far from settlement, scattered woodland as well as some woodland are all completely artificial landscapes. However traffic corridors including railway, highway, rural roads and etc. are special artificial landscapes and they are the linkages of various spatial locations of human activities. And they also affect the spatial pattern of other man-made landscapes(CHEN *et al.* 1996). At a range of 5km to each side of railways(Lanzhou – Urumqi railway and Lanzhou – Xining railway) and national highways(103 and 312 national highways) there intensely distributed urban area, rural settlement and industrial area, which respectively account for 98. 89%, 64. 46% and 87. 82% of the whole area of their same types. And 88. 06% of orchard is intensely distributed at a rang of 5km to each side of railway, national highway and county-rural road. The three landscapes of farmland, orchard and rural settlement interlace frequently in the district.

6 TWO POINTS ON LANDSCAPE OPTIMIZATION AND MANAGEMENT

The aim to study regional landscape is to open out the factors, which affect and control the landscape pattern, and their mechanism by analyzing the structure characteristics of landscape mosaic in the different regions in order to provide the scientific bases for optimizing and managing landscapes. According to the above study, we stress two basic problems on optimizing and managing landscapes. One is to convert cultivated land in the mountainous area with a slope above 25° to woodland or grassland. The other is to scientifically plan rural settlement and industrial area, especially industrial area far from settlement.

6. 1 Converting Cultivated Land with a Slope above 25° into Woodland and Grassland

By overlaying slope map and landscape mosaic map, we find that there is 1775. 54ha of farmland, accounting for 29. 87% of the whole farmland in the district, which is distributed in the southern and northern mountainous areas with a slope above 25°. From points of view of environment conservation and rational land use, all the farmland should be converted into woodland or grassland. According to land suitability evaluation, we give the two suggestions that in the southern mountainous area, the farmland on the hillsides facing to the Sun should be converted into grassland and the farmland on the hillsides not facing to the Sun should be converted into grassland; and in the northern mountainous area, all the farmland should be converted into grassland.

6. 2 Planning Rural Settlement and Industrial Area

Our research has proved that rural settlement and industrial area far from settlement are distributed dispersedly and are lack in planning and there exist serious irrational approvals and construction. We make suggestions from the problems mentioned above that rural construction land and industrial area far from settlement should be planned and managed scientifically. In the terms of relational laws, rural settlement and industrial area far from settlement should be built or rebuilt compactly in the planned area.

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