

# **Spatial Pattern of the oasis landscape Ecotone in Ebinur**

## **Lake,Xinjiang,northwest of China**

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**Abstract:**Based on methods of lanscape ecology and TM images of the Ebinur lake during the diffierent period, This paper studies the characteristics of landscape pattern, function and its variation. The ecological process, mechanism and intensity of variation influenced by the human activities and physical factors are analyzed in order to offer the countermeasure and references for restoring and reconstructing destroyed ecological function in the study areas. The results showed that: (1)Landscape ecotone of Ebinur Lake, with higher complex spatial heterogeneity in ecological system,was fragile and unstable to disturbance of the human activities and environment factors, which mainly include rainfall variation, frequency and intensity of wind as well as population,agriculture and livestock changes. (2)The grassland is a dominant type of land use. The proportion of grassland, woodland and the unutilized land is nearly 80% while the agricultural land and inhabitant location is less, less than 8%. Thus, the land use structure should be adijusted to sustain the stability of oasis in Ebinur Lake .Especially three farms near the lake should control the increase of agricultural lands and livestock. (3)The land that not to utilize and the patches of woodlands are 94.78%, but this two kinds of landscape's average area is small, landscape fragment is obvious. (4)The shapes of grassland patches are not regulations and complicated,the bend level of boundary is distinct.The index of the landscape diversity and homogeneity is high, dominant is small, the distribution of landscape patches is symmetrical. The results indicate the landscape the landscape is complete, and have not

phenomenon of obvious fragment. (5) Study on ecological restoration of the unutilized lands should be strengthened, which is important for optimizing the composition structure and spatial pattern of landscape ecotone of Ebinur Lake. The unutilized lands including salina land, wind-erode land and water corrosive land, were distributed in areas with large population. Therefore, it is essential that we should prevent desertification and protect present vegetation and improve vegetation coverage. (6) The landscape ecology system was characterized by complicated and landscape patches fragment and higher diversity and homogeneity, which is related to climate change, human activities, groundwater level and lake volume change. Thus, we need to ensure the water supply for the lake, which provides references and information for biological resources, agriculture and railroad security.

**Keywords:** Ebinur Lake, oasis landscape ecotone, landscape pattern

## **1 Introduction**

Oasis are unique intrazonal landscapes in arid and semi-arid regions of the world. In China they are mainly distributed in temperate and warm temperate desert areas in the west of the Helan Mountain and north of the Qinghai-Tibet Plateau. Oasis take up only 7-8% of the total area of Xinjiang, over 90% of the population and over 95% of social wealth are concentrated within the oasis. Thus, oases are very important for economic development and environmental protection in arid and semi-arid regions. To study the stability of oases, what needs to be discussed are the conditions for the stability of vegetation in the transitional zone between oases and deserts: oasis-desert ecotone. Oasis-desert ecotone, with the function of oasis and desert ecosystem, forms a special structure and shape. Under the condition of global climate warming, landscape ecotone of oases is better weak and significant to indicating and forecasting the future. Based on methods of landscape ecology and TM images of the Ebinur Lake during different periods, this paper studies the characteristics of landscape pattern, function and its variation, which will provide some theoretical information for protecting the ecological environment and utilizing the natural resources.

## 2 Study area

The study area is located in Northwest China between the range of 82°35' ~83°10' E, 44°54' ~45°09' N. The Ebinur lake covers area of 4327.04km<sup>2</sup> and is a central of catchments basin. Tstrong-wind day (>20m/s)per year is more than 165 days in the Alsankou mountain, northern Ebinur lake . The desert vegetation in study areas wound adjust ecological founction because of its especial location and degraded envirnment.

## 3 Methodology

This paper studies the characteristics of landscape pattern, function and its variation, the ecological process, mechanism and intensity of variation influenced by the human activities and physical factors are analyzed in order to offer the countermeasure and references for restoring and reconstructing destroyed ecological function in the study areas.

Number of pitches(NP): NP=N<sub>i</sub>

Mean patch areas(MPA): MPA=a<sub>i</sub>/n<sup>i</sup>

Percentage of average pitches perimeter to area (PARA<sub>i</sub>): PARA<sub>i</sub>=  $PARA_i = \frac{\sum P_i / A_i}{N_i}$

Patch density(PD):  $PD = N_i / A$

Fragment index(FRAC):  $FRAC = \frac{2 \ln 0.25 P_i}{\ln A_i}$

Landscape shape index:  $LSI = \frac{P_k}{2 \cdot \sqrt{\pi \cdot A_k}}$

Diversity index:  $H = -\sum P_k \cdot \ln(P_k)$

Dominancy index:  $D = H_{\max} + \sum P_k \cdot -\ln(P_k)$

Even index:  $\varepsilon = \frac{H}{H_{\max}} = \frac{-\sum P_k \cdot \ln(P_k)}{\ln(m)}$

Cracked index:  $C = n_i / MPA$

## 4 Result and analysis

### 4.1 Spatial structure of land cover/use

Form the land types of oasis ecotone in Ebinur lake (Table 1), the grassland,

forest land and unutilized land were the dominant land types, their areas were 40.38%, 22.38% and 16.83% of the total study areas, respectively. While the percentage of agrarian land and residential land was least, only 7.18% and 0.1%.

Table 1 Landscape areas of different land type in Ebinur Lake

Land type	Land areas (m <sup>2</sup> )	Percentage of total (%)
Agrarian land	310818030.7	7.18
Woodland	968450078.8	22.38
Grassland	1747473240	40.38
Waterland	567674738	13.12
Residential area	4329971459	0.10
Unutilized land	728289856.7	16.83
Total	4327035616	100

The patch numbers were 721 with regard to the landscape types in study areas (Table 2), in which number of unutilized land was most, up to 48.68%, the second most was forest land, up to 46.19%, but their areas were less and cracked intensity was stronger. The least the patch number was grassland and water area while the landscape shape index of grassland was largest, up to 125.89. The landscape shape index of water areas was least, up to 1.4414. Thus, landscape ecotone of Ebinur lake was higher complex spatial heterogeneity in ecological system, with grassland as a based landscape, woodland as a zonal distribution in northeastern lake and roadway or channel as path of landscape.

Table 2 Landscape index of land use in oasis ecotone of Ebinur Lake

Type	NP	PD	MPA/m <sup>2</sup>	PARA <sub>i</sub>	FRAC	LSI
Agrarian land	27	6.24E-09	11511778.91	0.0039	1.2235	10.0391
Woodland	333	7.70E-08	2908258.49	0.0123	1.3209	31.1974
Grassland	1	2.31E-10	1747473239.75	0.0107	1.4431	125.8859
Waterland	1	2.31E-10	567674738.94	0.0002	1.0243	1.4414
Residential area	8	1.85E-09	541246.43	0.0082	1.1578	3.7681
Unutilized land	351	8.11E-08	2074899.88	0.0223	1.3899	61.1683

The diversity of landscape in study area was more abundant (Table 3). The diversity index (H) was 1.4637. The dominance index was less, up to 0.33, while the

even index was higher, up to 0.8169. The cracked index(C) was  $1.67E-07$ , which means that the distribution of landscape type was comparatively symmetrical and integrated.

Table 3 the landscape index of oasis ecotone in Ebinur lake

H	D	E	C
1.4637	0.33	0.8169	$1.67E-07$

#### 4.2 Spatial characteristic desertification landscape structure

From the cause types of desertification (table 4): the salination land and wind erosion land was the main landscape type, was 41.23% and 30.13% of the total areas, respectively. This indicates that the salination and wind erosion were the main factors threatening ecological environment of oasis ecotone in Ebinur lake.

Table 4 The desertification landscape area of oasis ecotone in Ebinur Lake

Type	Area/m <sup>2</sup>	Percentage of total area/%
Not-desertification	45142828	1.04
Desertification	Wind erosion	$1.31E+09$
	Water erosion	$5.54E+08$
	water	$6.44E+08$
	Salination	$1.79E+09$
Total	$4.34E+09$	100.00

From the landscape index (Table 5), the patch numbers of salination and wind erosion lands were largest, up to 455 and 260, respectively. Both of them were 89.60% of total numbers and their areas were up to 71.37%, which were the main types of desertification landscape. The salination lands were located in southern plains of Ebinur lake and around the Alsankou mountain, which were strongly affected by the human activities. The wind erosion lands were distributed mainly in northern and western areas of Ebinur lake. Affected by the wind, the indices of  $PARA_i$  and LSI in wind erosion areas were small. The phenomena showed that the shape of desertification landscape was simple and large-scale distributed.

Table 5 the desertification landscape index of oasis ecotone in Ebinur Lake

Type	NP	PD	MPA/m <sup>2</sup>	$PARA_i$	FRAC	LSI
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Not-desertification	60	1.38E-08	752380.47	7.67E-03	22.74	14.53
Wind erosion	260	5.99E-08	5033547.74	3.06E-03	27.64	31.28
Desertification	22	5.07E-09	25203310.48	1.23E-03	24.10	8.19
Watererosion	1	2.30E-10	643929119.74	1.73E-04	20.46	1.24
water	455	1.05E-07	3936041.59	2.87E-03	28.13	34.27
Salination						

The diversity of desertification landscape was 1.32, as shown in Table6, which show a higher abundance in desertification landscape. The index of D was less, less than 0.3 while the index of E was higher, up to 0.82. Furthermore, the index of D was 1.47E-04, indicating that the desertification landscape was comparatively even and integrated.

Table6 desertification landscape index of oasis ecotone in Ebinur Lake

H	D	E	C
1.32	0.29	0.82	1.47E-04

#### 4.3 Variation of vegetation landscape structure

The vegetation type is mainly composed of Haloxylon Ammodendron desert and salt marsh. Their areas are 34.69% and 14.71% of the all vegetation areas (Table 7). Haloxylon Ammodendron desert is distributed continually in northwest, north, northeast and east areas of Ebinur Lake. Salt marsh appears in the paralimnion and bottom of dried lake. The areas of agrarian land, half-shrub desert and succulent saline desert are similar and distributed scatteredly, up to 9.36%, 9.31%, 8.16% and 8.06%, respectively, while the areas of other vegetation types are small.

Table7 the vegetation landscape areas of oasis ecotone in Ebinur Lake

Type	Area (m <sup>2</sup> )	Percentage of total areas(%)
Agrarian land	420619788.64	9.32
Succulent saline desert	368731427.00	8.16
Half-shrub desert	422768476.16	9.36
Tamarix ramosissima	364103140.05	8.06
Haloxylon Ammodendron	1567722293.26	34.69
Sbrub desert	11096792.36	0.25
Saliniuzed meadow	149069574.98	3.30
Salt marsh	664745199.29	14.71

Ture steppe	8978015.16	0.20
Reed-swamp	280576552.66	6.21
Desert steppe	31755912.58	0.70
Deciduous forest	94759924.51	2.10
Artemisia desert	133548854.04	2.96
Bare land	327450.29	0.01
Total areas	4518803400.97	100.00

Table 7 shows the vegetation landscape index of oasis ecotone in Ebinur Lake. The numbers of patch in all vegetation types are 733, in which the NP of Haloxylon Ammodendron desert is largest, up to 247, amounting 33.7% of all patches. The second largest NP is half-shrub desert and Reed-swamp. Both of them are 126, up to 17.19% of all patches. The NP of Tamarix ramosissima is 70. The NP of other vegetation is small. The PARAI of most vegetation types is smaller while their LSI is different significantly. For example, the LSI of Reed-swamp is 31.01. that results shows that there exist complex landscape shape in different vegetation types of oasis ecotone in Ebinur Lake.

Table 8 the vegetation landscape index of oasis ecotone in Ebinur Lake

Type	NP	PD	MPA/m <sup>2</sup>	PARAI	FRAC	LSI
Agrarian land	32	7.08E-09	1.31E+07	4.48E-03	26.13	25.95
Succulent saline desert	13	2.88E-09	2.84E+07	1.93E-03	24.17	10.43
Half-shrub desert	126	2.79E-08	3.36E+06	3.92E-03	25.87	22.73
Tamarix ramosissima	70	1.55E-08	5.20E+06	4.16E-03	25.69	22.37
Haloxylon Ammodendron	247	5.47E-08	6.35E+06	2.50E-03	27.59	27.96
Sbrub desert	2	4.43E-10	5.55E+06	2.13E-03	17.36	2.00
Saliniuzed meadow	4	8.85E-10	3.73E+07	3.44E-03	23.52	11.85
Salt marsh	3	6.64E-10	2.22E+08	5.19E-04	22.73	3.78
Ture steppe	1	2.21E-10	8.98E+06	2.29E-03	17.09	1.93
Reed-swamp	126	2.79E-08	2.23E+06	6.56E-03	26.08	31.01
Desert steppe	1	2.21E-10	3.18E+07	1.27E-03	18.43	2.02
Deciduous forest	37	8.19E-09	2.56E+06	5.39E-03	23.51	14.80
Artemisia desert	1	2.21E-10	1.34E+08	4.02E-04	19.01	1.31

The diversity of vegetation landscape and the index of D were higher, up to 2.03 and 0.53, respectively. The salina plants were dominant vegetation type.

However, the index of E was less, 0.79. The index of C was 9.76E-05, indicating there were higher even and sufficiently not cracked in vegetation landscape (Table 9).

Table 9 The vegetation landscape index of oasis ecotone in Ebinur Lake

H	D	E	C
2.03	0.53	0.79	9.76E-05

#### 4 Discussion

The landscape pattern, function and its variation in oasis ecotone of Ebinur Lake are mainly caused by human activities and climate change. The human activities are mainly represented by changing lake water areas and agrarian land. Based on data from meteorologic and hydrological satations in study areas, compared with 1950's, the temperature is higher 0.3 °C in 1990's, while the precipitation increased by 20% - 50%. Thus, the rainfall in Ebinur Lake basin would increase 5% - 20%, which result in increasing the runoff and enlarge the lake water areas. The lake water areas keeps 500 km<sup>2</sup> in recent years. However, with continually increasing population in study areas, the agrarian land areas expand greatly and the demand for water also increased dramatically. From 1980's to 1990's, the agrarian land areas enlarge 244.75 km<sup>2</sup>, increasing by 16.96%. The irrational human activities results to decline water supply for Ebinur Lake basin and cause some ecological problems. Therefore, the human activities is an important factor to disturbing landscapes spatial structure of oasis ecotone in Ebinur Lake.

#### 5 Conclusions

(1) Landscape ecotone of Ebinur Lake, with higher complex spatial heterogeneity in ecological system, was fragile and unstable to disturbance of the human activities and environmental factors, which mainly include rainfall variation, frequency and intensity of wind as well as population, agriculture and livestock changes.

(2) The grassland is a dominant type of land use, the proportion of grassland,



woodland and the unutilized land is nearly 80% while the agricultural land and inhabitant location is less, less than 8%.

(3) The unutilized lands including salineland, wind-erode land and water corrosive land, were distributed in areas with large population. Therefore, it is essential that we should prevent desertification and protect present vegetation and improve vegetation coverage.

(4) The landscape ecology system was characterized by complicated and landscape patches fragment and higher diversity and homogeneity, which is related climate change, human activities, groundwater level and lake volume change.

### **Acknowledgement**

This work is supported by National desert-metrological Research Foundation of China (Grant No.SKJ2007006).

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