Remote Sensing Dynamic Monitoring and Genetic Analysis of Horqin Sandy Land Based on GIS ——Take Kulun Qi in Tongliao City as an Example

Remote Sensing Dynamic Monitoring and Genetic Analysis of Horqin Sandy Land Based on GIS ——Take Kulun Qi in Tongliao City as an Example

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Abstract. Based on the support of the MAPGIS platform and using the four-stage remote sensing data of MSS \TM\ ETM\ TM, the dynamic change of desertification in Kulun Banner of Tongliao City is obtained, and the reasons for the growth and decline of desertification in Horqin City are analyzed with the data of climate, population and cultivated land area. The results show that the desertification area of Kulun Banner has increased and decreased in the past 40 years. The center of severe desertification has been located in the northern edge of animal husbandry. The climate in Tongliao area tends to be dry and warm, population growth is relatively fast, and land use structure changes are closely related to the evolution of Horqin Sandy land.

1. Introduction

The world is defined as the “desert”, accounting for 1/4 of the earth's land surface, with a total area of nearly 3.37×10^7 km^2, with more than 500 million people living in it [1]. Horqin Sandy Land（42°41′-45°15′N, 118°35′-123 °30′E）is one of the four major sands in China. Across the three provinces of Inner Mongolia, Jilin and Liaoning, The sand area5.17×10^4km^2. Its main part is located in Inner Mongolia, accounting for 92.4% of the total area. Horqin Sandy Land is a fragile and sensitive agro-pastoral ecotone in China[2].

Kulun Banner 42°21′-43°14′N,121°09′-122°12′E) is located in the southwestern part of Tongliao City, Inner Mongolia Autonomous Region, at the southwestern end of Horqin Sandy Land, and it belongs to the Bohai Economic Zone and the Northeast Economic Zone. The Kulun Banner is located at the intersection of the mountainous area of western Liaoning and the Horqin Sandy Land. The terrain of the whole flag is densely covered with hilly and gully in the south-central part of the country. Total land area of the whole flag 4.72×10^3km^2, cultivated area 9.66×10^2km^2, Have jurisdiction over 6 townships and 1 state-owned forest farm and 187 villages. The north-central part of the Kulun Banner is one of the typical areas for grassland colonization[3], Serious desertification. Since 2002, Cullen Banner has taken effective measures to effectively curb the development of desertification. This paper studies the remote sensing data of the Horqin Sandy Land in Kulunqi in the past 40 years, reveals the changes and causes of desertification in the Horqin Sandy Land in the study area, and draws conclusions. In order to provide a scientific basis for the smooth implementation of the project of returning farmland to forests and grassland and the next work arrangement of the decision-making department, and to serve the ecological environment construction and sustainable development of the

Kulunqi.

2. Source and processing of data

Using the remote sensing image data of 1975, 1990, 2000 and 2015 for correction, mosaic, color adjustment, stretching, enhancement, etc, the remote sensing image is rich in color, level and stereo, which is convenient for computer human-computer interaction. It can extract the information about rivers, lakes and desertification in the study area, and then establish the interpretation mark. Finally, the MAPGIS software is used for laboratory interpretation, and the uncertain locations in the interpretation process are field-checked. The study area is detailed in remote sensing interpretation data; the statistics of the Kulun Banner over the years are checked, and the population and cultivated land data of the Kulun Banner are obtained. Land use data comes from the Kulunqi government work report. The meteorological data are all from the website of the China Meteorological Administration. Since the specific meteorological data of the Kulun Banner cannot be found, the temperature and precipitation data in the analysis of the natural causes of the desertification change in the study area are the data of the Tongliao area.

3. Dynamic changes in desertification in the study area

3.1 Comparison and Dynamic Analysis of Total Desertification Area in Research Area

3.1.1 Remote sensing interpretation results

The MAPGIS software platform was used to interpret the four-phase remote sensing data (*Figure 1-4*), which scientifically reflected the desert changes in the Kulun Banner in the past 40 years. In the study area, the area of desertification and moderate desertification account for the smallest proportion of total desertification area, followed by moderately, and the proportion of light desertification area is the largest.（*Table 1*）.

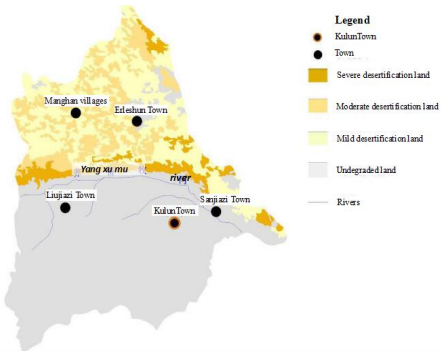

Figure 1 Distribution map of the Kulunqi desert in1975

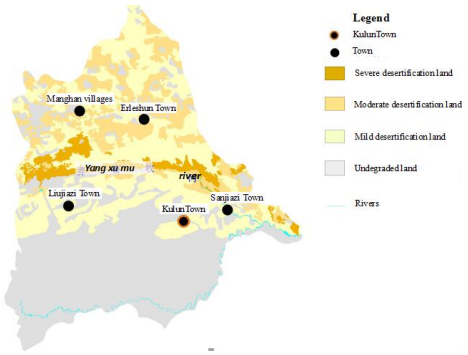

Figure 2 Distribution map of the Kulunqi desert in 1990

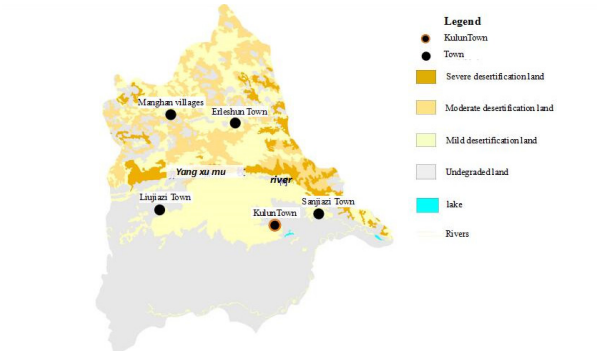

Figure 3 Distribution map of the Kulunqi desert in 2000

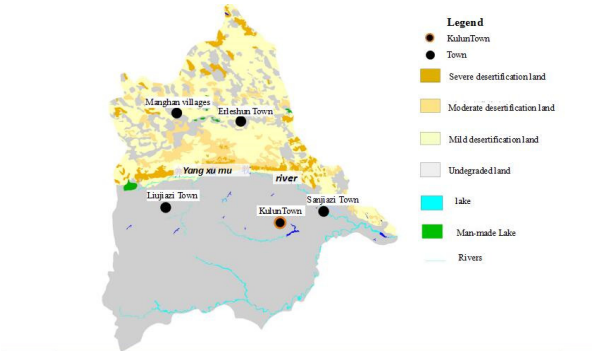

Figure 4 Distribution map of the Kulunqi desert in 2015

Table 1 1975-2015 Kulunqi Desertification Area Table

Desertified area（km^2）	1975year	1990year	2000year	2015year
Severe desertification	245.25	221.93	279.73	180.69
Moderate desertification	540.32	696.27	643.87	233.38
Mild desertification	1018.81	1480.53	1345.69	1117.46
total	1813.38	2398.73	2269.29	1531.53

3.1.2 Analysis of Desertification Dynamics in Research Areas in Recent 40 Years

The dynamic degree parameters in land use/land cover research are used to express the dynamic trend of desertification in the study area. Computer model is[4].

$$K = \frac{U_a - U_b}{U_a} \times \frac{1}{T} \times 100\% \quad \text{(Eq.1)}$$

Where: K is the desertification dynamics during the study period. When K>0, the desertification area showed a decreasing trend; when K<0 desertification area showed an increasing trend; Ua and Ub were the desertification area at the beginning and end of the study area respectively; T was the long study period.

Table 2 Desertification dynamics during the three study periods from 1975 to 2015

Desertification type	Dynamic degree（%）		
	1975—1990year	1990—2000year	2000—2015year
Severe desertified land	0.63	−2.6	5.06
Moderate desertified land	−1.92	0.75	9.11
Mild desertified land	−2.55	0.91	2.42
Total	−2.15	0.54	4.64

According to the calculation and comparison of *Table 2*, the desertification in the study area spreads from 1975 to 1990, and the moderate and mild desertification spreads extremely fast; from 1990 to 2000, the desertification area is reversed, and only the severe desertification area is still

spreading; 2000- In 2015, the desertification area was significantly reversed, and the three types of desertification areas were shrinking sharply.

3.2 Analysis of spatial variation of desertification in each year of the study area

3.2.1 Desertification in the Kulun Banner in 1975
According to Table 1 and the 2000 Kulunqi remote sensing image (*Fig. 1*), the desertification area in Kulunqi in 1975 was 1813.38 km^2, accounting for 38.5% of the total area of the whole flag, mainly concentrated in the northern part of Kulunqi. The area of severe desertification is 245.25km^2, accounting for 13.5% of the desertification area. It is distributed in the northern marginal area of the Yangxumu river. In addition, there are sporadic distributions in the eastern and northern parts of Sanjiazi Town and the northern part of the Northern Erleshun Town. The moderate desertification area is 540.32km^2. It accounts for 29.8% of the desertification area, mainly distributed in most areas of Suhan and Suxun Towns; the area of mild desertification is 1018.81km^2, accounting for 56.7% of the desertification area, mainly distributed in the northern part of Sanjiazi Town, Erleshun Town and parts of Manghan villages.

3.2.2 Desertification in the Kulun Banner in 1990
According to Table 1 and the 1990 Kulunqi desertification remote sensing image (*Fig. 2*), the desertification area in Kulunqi is 2398.73 km^2, accounting for 50.86% of the total area of the whole flag. The area of severe desertification is 221.93 km^2, accounting for 9.25% of the desertification area. It is mainly distributed in the northern marginal area of the Yangxumu river, and is also distributed in the northern part of Sanjiazi Town.The moderate desertification area is 696.27km^2, accounting for 29.03% of the desertification area. It is mainly distributed in the northern part of Sanjiazi Town, most of the areas of Manghan and Erleshun Town; the light desertification area is 1480.53km^2, accounting for 61.72% of desertification area, mainly distributed in most areas of Kulun Town, Liujiazi Town, Sanjiazi Town, Erleshun Town and Manghan villages.

3.2.3 Desertification in the Kulun Banner in 2000
According to Table 1 and the 2000 Kulunqi remote sensing image (*Fig. 3*), the desertification area in Kulunqi is 2269.29km^2, accounting for 48.12% of the total area of the whole flag. The area of severe desertification is 279.73km^2, accounting for 12.2% of the desertified area. It is mainly distributed on the northern marginal area of the Yangxumu river, and has been expanded in the north of Sanjiazi Town and the Erleshun part of the country. The northwest and southeast of Manghan Township are distributed; the moderate desertification area is 643.87km^2, accounting for 28.37% of the desertification area, distributed in Sanjiazi Town, Erleshun Town and Manghan Township area. Compared with 1990, there is no obvious change in the distribution area; mild desertification The area is 1346.69km^2, accounting for 59.43% of the desertified area. It is mainly distributed in almost all areas between Kulun Town and Liujiazi Town. It is also widely distributed in the areas of Erleshun Town and Manghan villages.

3.2.4 Desertification in the Kulunqi Banner in 2015
According to the analysis of Table 1 and the 2015 Kulunqi remote sensing image *(Fig. 4*), the desertification area in Kulunqi is 1531.55km^2, accounting for 32.48% of the total area of the whole flag. The area of severe desertification is 180.69km^2, accounting for 17.8% of the desertification area. It is mainly distributed in the northern edge of Yangmumu river, the northern part of Sanjiazi Town, the western part of Manghan villages and the northern part of Erleshun. The moderate desertification area is 233.38km^2, accounting for 15.24% of the desertification area, mainly distributed in Sanjiazi Town, Eileshun Town and Manghan villages. The area is significantly reduced compared with 2000; the light desertification area is 1117.46km^2, accounting for 69.96% of the desertification area. It is in the northern part of Sanjiazi Town and in most of the areas of Erleshun Town and Manghan villages.

3.2.5 Comparative Analysis of Desertification Space Dynamics in Cullen Banner from 1975 to 2015
From 1975 to 1990, in 1975, there was no moderate desertification in Sanjiazi Town, but in 1990, there was moderate desertification. The distribution of mild desertification rapidly expanded. It has broken through the Yangxumu river defense line and expanded southward to Kulun Town and Liujiazi Town and most of the Sanjiazi Town; The land with severe desertification expands northward at the source of the Yangxumu river, but the extent is very small. In 1975, the severe desertification in the northern part of the town of Erleshun disappeared, and the changes in other areas were not obvious. Overall, the area of severe desertification is decreasing. From 1990 to 2000, The area of light desertification in most townships on the south side of the Yangxumu river is decreasing. the country is only concentrated in the middle of the area of Kulun Town and Liujiazi Town, the rest disappeared basically; but the area of severe desertification was spreading and the speed was fast, and it increased rapidly in the northern part of Sanjiazi Town and in the eastern part of Erleshun. From 2000 to 2015, The area of severe desertification concentrated in the northern margin of Yangxumu river is obviously reduced. In other areas, it's only sporadic. Before 2000, desertification in Mangham and Erleshun towns was very serious. From 2000 to 2015, the degree of desertification in these townships was reduced, and desertification in many areas had disappeared.

4. Analysis of the Causes of the Change of Desertification Area in the Study Area

4.1 Analysis of Temperature and Precipitation Change in Kulun Banner in Recent Years
According to the statistics of the National Meteorological Administration, the annual average temperature, the highest average temperature and the lowest average temperature in the study area of Kulun Banner showed a significant upward trend from 1951 to 2015[5]; From 1976 to 2015, the average temperature of the Kulun Banner in the past 40 years basically showed an upward trend year by year. The highest annual average temperature appeared in 2007, which was 8.8℃, and the lowest in 1976, which was 6.1℃. The difference between the two was 2.7℃. From 1976 to 2015, the average temperature increase rate was 0.213℃/10 a 1976-2015, and the annual precipitation in Kulun Banner in recent 40 years showed a significant downward trend, with the precipitation change tendency rate of -6.747 mm/10 a. From this we can see that the annual average temperature of Kulun Banner has been fluctuating and rising in recent 60 years, but it is consistent with the trend of climate warming in China[6].

4.2 Correlation analysis of population, cultivated land and desertification in the study area
The human factors for the formation of desertified land include human unreasonable economic activities and disturbances to the intensity of the land. Accelerated land desertification due to excessive population growth, excessive land reclamation, overgrazing and over-exploitation[7].

The population size and cultivated area were selected as the indicators of human factors. Between 1975 and 2015, the population of the study area has been growing, with an average annual growth of 1444.9 people. During the 15 years from 1975 to 1990, the population increased by 32,562, with an average annual growth rate of 2170.8. The growth rate was faster than that of the entire study period. During this period, the population grew faster and the desertification area grew at the fastest rate. From 1990 to 2000, the population increased by 11,849, an average annual increase of 1184.9; from 2000 to 2015, the population increased by 1,826, an average annual increase of 260.9. The population growth rate during these two time periods is less than the average growth rate, and the growth rate is getting smaller and smaller, which is consistent with the desertification area dynamics *(Figure 5*).

The area of cultivated land in the study area was the highest in 1990, and increased by 397.38km^2 in 15 years, with an average annual increase of 26.49km^2. At this time, the desertification area in the study area also reached the maximum. By the year 2000, the area of cultivated land decreased by 282.52km^2, with an average annual decline of 28.25km^2, and the desertification area also declined. This indicates that local people have begun to prevent desertification. The area of cultivated land has been declining for 15 years from 2000 to 2015 (*Figure 6*). In particular, since the implementation of

the project of "returning farmland to forests and grassland" in Kulunqi in 2002, a total of 1,700 km^2 of grassland and grassland has been realized, and the desertification area has been treated at 866.67 km^2, and the treatment rate has reached75%.

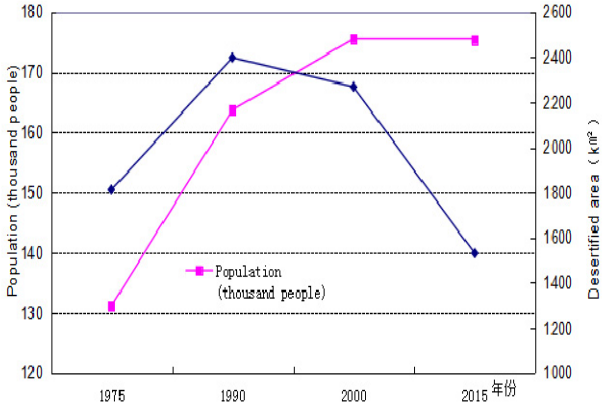

Figure 5: Change in population and desertification area of Cullen Banner from 1975 to 2015 (population data from Kulunqi Statistics Bureau data)

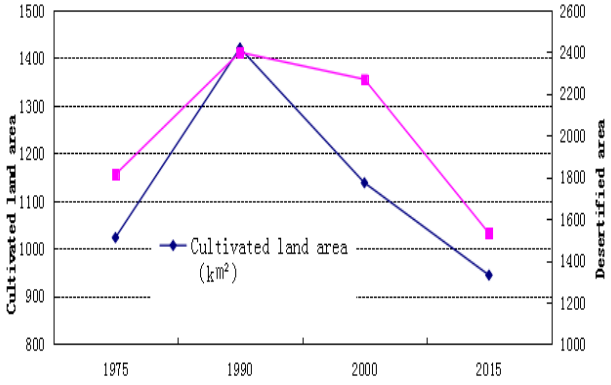

Figure 6: Change of cultivated land and desertification area in Cullen Banner from 1975 to 2015 (cultivated land data from Kulunqi Statistics Bureau)

5. In conclusion

The formation process of desertified land is essentially the process of soil material redistribution, combined with the vegetation loss process under the combined effect of human activity and environmental climate, that is, land degradation under the combined action of rich sand and wind power. process. Therefore, the formation of desertified land has both natural and human factors.

The natural factors that form desertified land include the material basis and climate elements of desertification. The material conditions formed by desertification are the existence of abundant sand materials, namely sand source; the climatic factors mainly refer to the characteristics of temperature, precipitation and wind power. Synergistic effect of wind and drought in the same season is the natural driving force of desertification formation. First, the desertification area of the study area has been concentrated in the northern area. The northern marginal area of the animal husbandry and river has always been the main distribution area of severe desertification, and most of the areas in the towns of Yuhansumu and Erleshun are deserted. Second, the desertification area of the study area increased and decreased during the three study periods from 1975 to 1990, 1990-2000, and 2000-2015. The dynamics were: -2.15%/a, 0.54%/a, 4.64%/a.

Third, the climate that has been warming up in the study area for nearly 40 years is an important external factor of desertification, and the key depends on the impact of human activities.

Fourth, the implementation of the project of "returning farmland to forests and grasslands" has obvious effects on desertification control in the study area.

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