DYNAMIC CHANGES OF GRASSLAND IN KERQIN REGION AND ANALYSIS OF DRIVING FORCE

Liping Chang, Yangzhen Zhang, Shuwen Zhang, Ying Li

Northeast Institute of Geography and Agricultural Ecology, CAS, Changchun 130012, P.R.China

ABSTRACT:

The Kerqin region is an important part of the temperate zone grassland in China. This paper has made a deeper analysis on the characteristics of grassland area, and its transformation and change speed through remote sensing image processing. These images were acquired in 1986, 1996 and 2000 respectively. The results have shown that the grassland in the region reduced 3200 $km^2$and the reclamation of arable land is its main reason. After analysis of region difference of dynamic change of the grassland, author have found that the grassland of Shuangliao County in Jilin Province changes more, reaching 2.7 per cent; but the grassland of Alukerqin banner belonged to Chifen City changed less year on year and was better protected. Human activities are a main driving force for grassland reduction in the region.

KEY WORDS: grassland, dynamic change, driving force analysis, Kerqin region

1 INTRODUCTION

Kerqin region is located in the eastern part of China, lying in the transition belt from the northeast Plain to the Inner Mongolia Altiplano. Its east starts from Shuangliao County of Jilin Province; its west stretches Balinqiao; its boundaries of north and south are in the loss hill of the north of Yanbei and the eastern foot of the Daxinganling Mountain. The administrative region of this study includes Shuangliao County of Jilin Province, Zhangwu County of Liaoning Province, Fuxin Mongolia Ethnic Autonomous County, Kerqin Right Wing Middle Banner, Zhalute Banner, Alukerqin Banner, Naiman Banner, Kulun Banner, Kerqin Left Wing Back Banner, Kerqin Left Wing Middle Banner and Kailu County of Inner Mongolia. Its area is 99440 km^2 (Fig.1). Since the third epoch, the relief development of the Kerqin region has closely joined with the eastern part of Inner Mongolia Hill. The late new structure movement has made the eastern slope descend and formed the terraced shape. The west Liaohe Plain went down and stored up a considerable thick gravel and clay. The whole region inclines from the west to the east, height above sea level from 650 m to 180 m, and sinks from the view of the north and the south. The region features a distinct continental climate. The temperature difference is larger, with an average temperature of 5.8 to 6.4 ℃ and the annual precipitation is between 343 and 451 mm. The shortage of precipitation has a serious impact on the farming and grazing production. The drought is a major natural disaster. Also, the region is an important part of the temperate zone grassland in China, and the grassland area reaches 40 per cent of the whole area and is an excellent grazing and mowing field (LIU, ZHAO and ZHAO, 1996).

2. ANALYSIS METHOD OF DYNAMIC CHANGES OF GRASSLAND

Based on data results of the two projects of a knowledge innovation of Chinese Academy of Sciences——National dynamic information system of basic resource and environment remote sensing and Analysis of space-time information of environmental remote sensing of country and preliminary study on relevant theory and technology for digital earth, the study took the following steps to extract interested data: Selecting 4,3,2 bands of TM data acquired for 1986, 1996 and 2000 respectively as three-temporal composite images, registering the image for 1996 with the relief map with the scale of 100,000, creating the interpretation marks based on the image pattern of the regional grassland and relevant land cover, conducting a man-machine mutual interpretation on the screen by the means of ArcView package, we extracted marsh information for 1986 finally. Afterwards, based on the previous image for 1986, rectifying the image for 1996, outlining the varied pixels of grassland for 1996 in comparison with the image for 1986. The same method for 2000, the changed data would be edited and corrected under the environment of the ArcInfo package and the final results were stored in the database (CHANG and ZHANG, 2002).

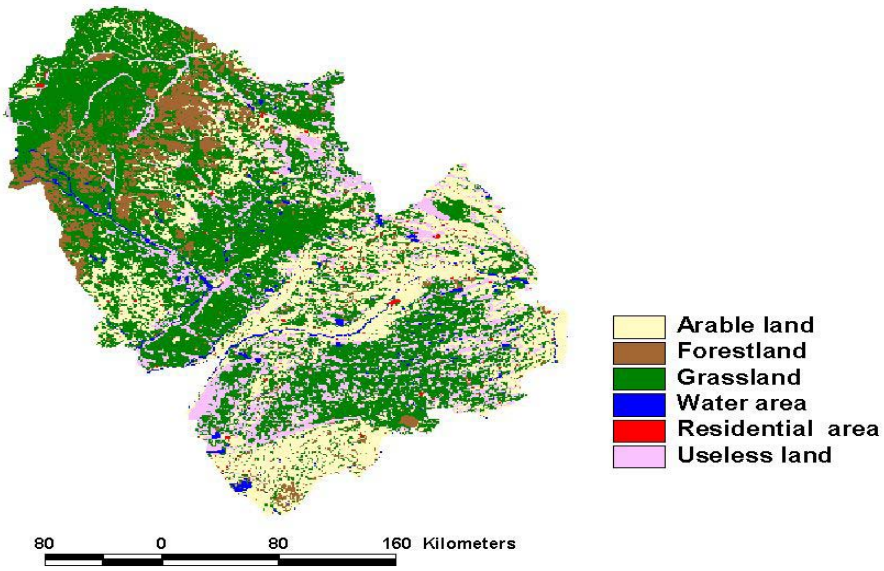

Fig. 1 Distribution map of grassland in Kerqin region

3. ANALYSIS OF DYNAMIC CHANGE OF GRASSLAND

3.1 Change of Grassland Area

Grassland is the most obvious land use/cover pattern in the Kerqin region during the last ten years (Fig.2). Its area decreased 3200 km^2 (Table 1) from 1986 to 2000. The total area of grassland was 43200 km^2 for 1986 and 419 km^2 for 1996 and reduced 1300 km^2 within 10 years, of which high overlay grassland lessened sharply to the tune of 1050 km^2, while middle overlay and degraded grassland amounted to some 100 km^2 respectively. The total area of grassland was 40100 km^2 for 2000 and reduced 1800 km^2 compared with 1996, which is nearly 2.7 times more than reduction ratio of the

previous ten years. The decrease of middle overlay grassland was uppermost, up to 1200 km^2 and high overlay grassland fell down to 750 km^2, on the contrary, the degraded grassland increased 100 km^2. The above analysis has shown that not only did the quantity of grassland decrease, but quality descended more or less.

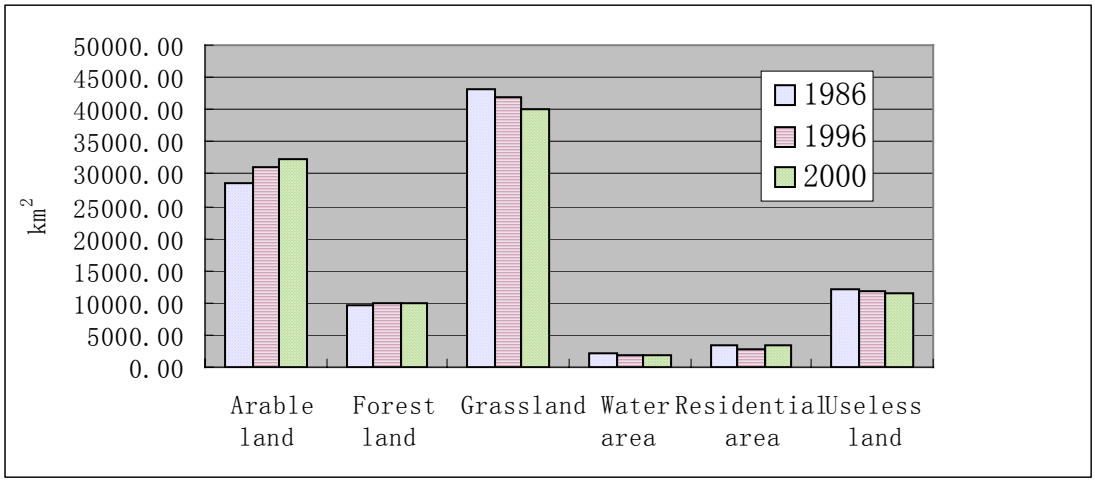

Fig 2 Space-time change characteristics of grassland and relative patterns in Kerqin region

Table 1 Characteristics of Grassland Change in Kerqin Region

Km^2

Grassland pattern	1986	1996	2000
High overlay grassland	23734.11	22678.87	21929.49
Middle overlay grassland	15422.19	15356.09	14170.79
Degraded grassland	4089.17	3853.86	3955.34
Total	43245.48	41888.82	40055.62

3.2 Transforming Characteristic Analysis of Grassland

The change of land use/cover is mostly divided into two classes based on its generant character——conversion and modification. The conversion means that the form of land use has ultimately changed from one to another. The main points in the region have the changes from grassland to arable land, forest land and useless land etc. the modification is that the form of land use have no radical change, that is to say, its attribute still remain its original cover or pattern. But its structure and function were remarkably changed for the different extent of use (LI, 2003). This kind of change in the region witnessed the variation between high, middle and low overlay grasslands.

The grassland area transformed to other land patterns amounted to 6530 km^2 within 15 years, in which paddy field and dry land were 5240 km^2, reaching 80 per cent of the transformed area and 13.1 per cent of the whole area of grassland for 2000 year. It has been seen that how human activities influenced the grassland. Next, the forestland is the second pattern of the transformation up to 1020 km^2, accounting for 15.6 percent. The above two patterns are a primary transformation form in the region from 1986 to

2000. Finally water area, residential area and useless area transformed are a secondary transformation form (Fig.3). Contrarily, the grassland area from other land patterns was 790 km^2 together, only retrieving 12.1 per cent from the transformed grassland, in which useless land was 460 km^2, arable land 180 km^2 and forestland 130 km^2, accounting for 96 per cent from other patterns to grassland area. In conclusion, the transformation character in the region mainly depended upon from grassland to other land patterns.

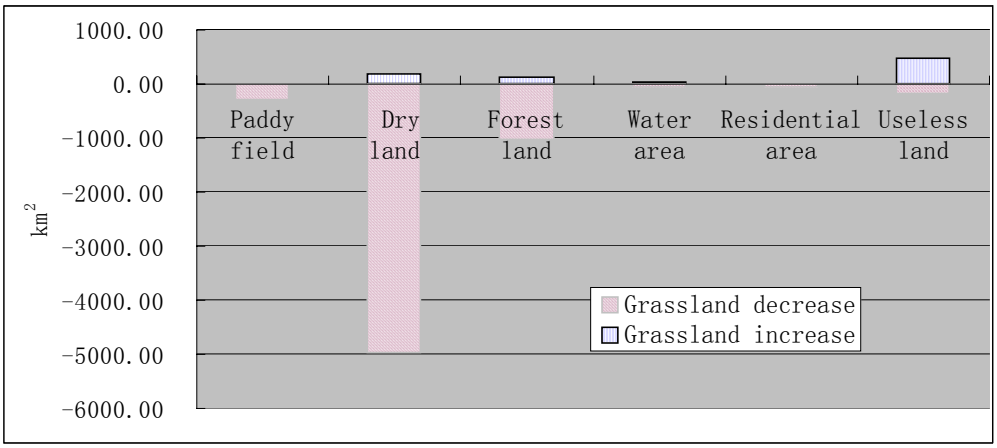

Fig. 3 transformation characteristics of grassland area in Kerqin region

Table 2 Transformation Characteristics of Grassland in Kerqin Region

Km^2

Pattern	Grassland increase (transformed to grassland)	Grassland decrease (transformed to others)
Paddy field	3.34	285.96
Dry field	177.97	4958.78
Forest	34.42	734.39
Shrubbery	6.42	96.38
Sparse forest	29.91	154.01
Other forest	54.36	35.23
Rivers	0	0.73
Lakes	1.71	12.67
Reservoir	2.77	0.96
Bottomland	16.12	30.08
Town	0	14.65
Countryside	0	40.76
Industrial land	0	0.14
Sand	419.51	61.99
Salina	6.07	62.40
Wetland	39.78	60.91
Total	792.38	6530.06

3.3 Modification Character of Grassland Itself

Grassland inside has also experienced a modification process except a large area of grassland was changed to other land patterns within 15 years. The high quality grassland was gradually changed to middle overlay grassland for 96 km^2 and degraded grassland for 12 km^2, totaling 32 per cent of the modification of grassland inside (Fig. 4, Table 3). At the same time, the middle overlay grassland was also changed to high overlay grassland for 76 km^2 and degraded grassland for 27 km^2. On the contrary, the degraded grassland, through different grade improvement, was back to high overlay grassland for 89 km^2 and middle overlay grassland for 39 km^2. By a serial of analysis of the modification of grassland inside, It is concluded that net increase of high overlay grassland for 56 km^2 and middle overlay grassland for km^2, and net decrease of degraded grassland for 88 km^2. For all, the proportion of the degraded grassland still is bigger than the other region of northeast China.

Table 3 Modification Characteristics of grassland in Kerqin Region

Km^2

Pattern	High Overlay Grassland	Middle Overlay Grassland	Degraded Grassland	Total
High Overlay Grassland	0	96.49	12.32	108.82
Middle Overlay Grassland	75.90	0	27.61	103.51
Degraded Grassland	89.10	39.25	0	128.35
Total	165.00	135.74	39.93	340.67

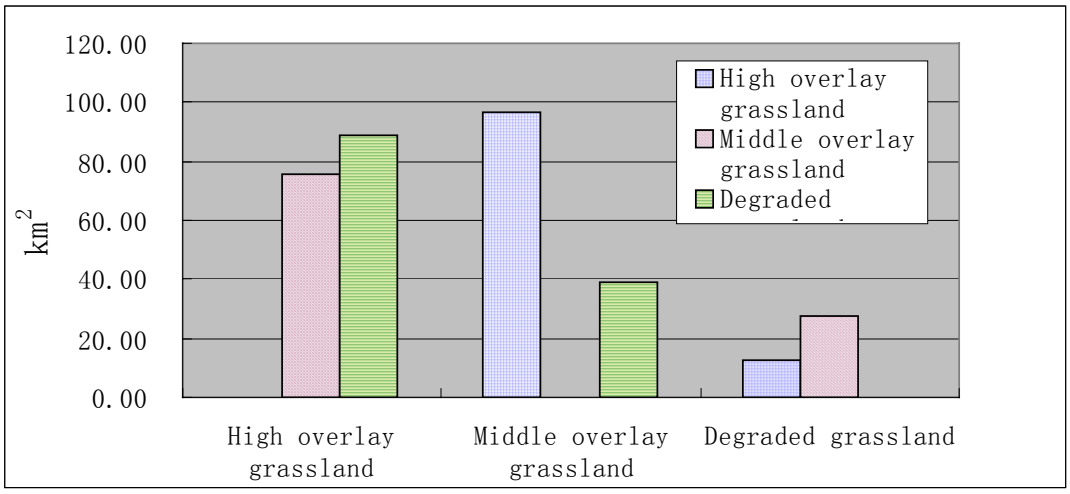

Fig. 4 Modification characteristics of grassland in Kerqin region

3.4 Speed of Dynamic Change of Grassland

Dynamic grade of land use is used to quantitatively describe the speed of space-time change of land

use/cover, which play an active role in comparison of regional difference and prediction of change trends in the future (ZHU, LI and HE *et al*., 2001). The dynamic grade of single land pattern reflects its quantity change status within certain time. The expression is as follows:

$$K = \frac{U_b - U_a}{U_a} * \frac{1}{T} * 100\%$$

Where U_b and U_a represent the quantities of certain land pattern at beginning and ending respectively, T is the length of study time. Suppose T is year, K is defined as the radio of annual changes for certain land pattern in a study period (LIU, DENG and LIU *et al*., 2002. The dynamic grade of grassland for every city or county can be computed based on the above formula (Table 4).

Table 4 Ratio of Annual Change of Grassland in Northeast China

Km^2

Name	Grassland Area in 1986	Grassland Area in 2000	Grassland change within 15 years	Ratio of annual change （%）
Alukerqin Banner	7230.44	7152.03	78.41	0.073
Kerqin Right Wing Middle Banner	6270.31	5919.99	350.32	0.394
Tongliao City	907.08	726.39	180.69	1.658
Kerqin Left Wing Middle Banner	3865.11	3414.14	450.97	0.881
Kerqin Left Wing Back Banner	5910.18	5597.51	312.67	0.372
Kailu County	1664.17	1549.04	115.13	0.495
Kulun Banner	1975.44	1755.31	220.13	0.836
Naiman Banner	2755.09	2430.88	324.21	0.889
Zhalute Banner	10966.66	10140.06	826.60	0.543
Fuxin Mongolia Autonomous County	7095.5	710.80	-1.25	-0.011
Zhangwu County	479.83	371.21	108.62	1.950
Shuangliao County	294.79	209.75	85.04	2.702

3.5 Analysis of Regional Difference of Dynamic Change of Grassland

There is an obvious regional difference in number according to the list of table 4, in which the maximum of change is Shuangliao County of Jillin Province because of a large amount of reclamation. The number of grassland changed has reached 40 per cent of the total grassland and its relative ratio of change is also biggest, up to 2.7 per cent. Zhangwu, Tongliao and Fuxin follow in order, their annual ratios of change are 1.95%, 1.66% and 0.011% respectively. In every city, banner or county but Tongliao, belonged to Inner Mongolia municipality, their change rate of grassland is basically close. Consequently, the change ratio in the Right Wing Middle Banner and Left Wing Back Banner of Kerqin

is lower than 0.4 per cent, while the change rate of the Alukerqin banner of Chifeng city is minimum, not up to 0.1 per cent, with a better protection of grassland.

4. ANALYSIS OF DRIVING FORCE DYNAMIC OF GRASSLAND

4.1 Natural Factors

Kerqin region is located in the edge belt affected by the southeast monsoon, with unstable climate. Its change rate of temperature and precipitation has obviously increased since 80's (LIU, ZHAO and ZHAO, 1996). In particular, for the last ten years, getting warmer of global climate has necessarily resulted in the aggravation of drought extent. In this case, the water level lowered, the lakes shrank or dried up, and some of them were transformed to grassland went on to useless land at last. In the meanwhile, drought also exerted an influence on the evaporation process and intensity of grassland surface, and growth status and succession that made the coverage of vegetation sparse and grass height lower. Hence the proportion of high quality grass decreased and the production force lowered. In addition, the soil in the region is mostly sandy. Sand flow blown by wind could be easily formed under the action of windy power, as a major factor affecting grass growth.

4.2 Policy Factors

"The Grassland Law of The People's Republic of China", adopted at the 11th Meeting of the Standing Committee of the Sixth National People's Congress and promulgated by Order No. 26 of the President of the People's Republic of China on June 18, 1985, and effective as of October 1, 1985, stipulates that the State should strictly protect grassland ecosystems, vegetation and rare plants, and prohibit adverse reclamation and construction activities. Rigorous measures shall be adopted to protect the vegetation of the grasslands; land reclamation and destruction of grasslands shall be prohibited. Where land reclamation has already caused aridity or serious soil erosion, the local people's governments at the county level or above shall close the area for a limited time and order the reclaimers to restore the vegetation and defer farming for a return to animal husbandry. Cutting or digging shrubs, medicinal herbs or other sand-fixation plants on desert or semi-desert grasslands or in arid areas shall be prohibited. No one may collect rare and precious wild plants from the grasslands without the approval of a people's government at the county level. Grasslands shall be used rationally and overgrazing prevented. Where aridity, degeneration or soil erosion occurs as a result of overgrazing, users of the grasslands shall be required to reduce grazing and resow forage grass so as to restore vegetation. Where man-made grasslands have already been established, extra control shall be administered; they shall be rationally managed and used in a scientific way, so as to prevent degeneration. So the law plays an active part in protecting grassland, which puts off and abates a large scale of reduction. But it is still very difficult to normalize man's doings.

4.3 Social and Economic Factors

Except forestland, water area and useless transformed from grassland the major reason of grassland reduction was caused by farming production extension. The food supplies required by population growth have to acquire from land. When the present land cannot meet the demand for mankind, in the

meanwhile, the progress of science and technology cannot also make up the requirement, reclamation of uncultivated land becomes an only approach. The hypsography of this area is comparatively flat and organic matter of soil is rich, therefore, the arable land is easily reclaimed from grassland, as viewed as resources in support. Also, the advancement of agriculture modernization level has provided a good condition for extension of arable land since 80s'. The above analysis has shown that mankind activities are a major driving force for grassland reduction. In addition, owing to the change of mankind's consumption level and structure, the number of livestock has greatly grown from 1986 to 2000, which put a heave burden on grassland. It often happened as overgrazing and desertification of grassland, also being an important factor resulted in grassland reduction.

So, under the guidance of the Law, man-made grassland should be established more and increase its accumulative quantity. Adjusting the intensity of grazing and strictly prohibiting cutting shrubs and picking and digging rare wild plants should be followed through. It is necessary to protect grassland vegetation, reuse farmland for husbandry gradually, patch grazing grass and restore vegetation. Finally, it also is important for us to reasonably and scientifically use grassland resources and preventing its degradation.

REFERENCES

CHANG Li-ping, ZHANG Shu-wen, 2002. Analysis of the expansion of the built-up area of Dalian City [J]. 12(4): 373-37

Grassland Law of the People's Republic of China, http://www.chinagate.com.cn/english/2153.htm

LI Ying, 2003. Space-time process and trend analysis of forest vegetation change in Northeast China, 61, Doctor's Dissertation. (in Chinese)

LIU Ji-yuan, DENG Xiang-zheng, LIU Ming-liang *et al*., 2002. Study on the spatial patterns of land-use change and analysis of driving forces in northeastern China during 1990-2000[J]. 12(4): 299-308

LIU Xinmin, ZHAO Ha-lin and ZHAO Ai-fen, 1996. Environment of Sand blown by wind and vegetation in Kerqin region [M]. Beijing: Science Press. (in Chinese)

ZHU Huiyi, LI Xiubin, HE Shu-jin *et al*., 2001. Space-time change analysis of land use in ring Bohai region [J], Journal of Geography, 56(3): 253-256. (in Chinese)