

**LAND USE AND ITS DYNAMIC STUDIES WITH LANDSAT IMAGES  
IN THE WATERSHEDS OF THE XILIN RIVER, CHINA**

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**ABSTRACT**

This is a pilot study of rangeland degradation in Xilin Gol Plateau of Inner Mongolia of the North China by using Landsat imagery. The plateau is relatively flat and temperate dry steppe is the main land cover. An unsupervised classification approach was used for the classification of the rangeland and for studying and better understanding rangeland degradation and reclamation in more than 20 years. The results showed that the rangeland degradation was very serious in 1987 and at this time saline grassland also covered a relatively large area, and it seemed there was some reclamation in 1996.

**1 INTRODUCTION**

Desertification means land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variation and human activities. Rangeland degradation, arable land degradation and forestry land degradation are the major changes in land use types which caused by desertification. According to the China country paper to combat desertification (CCICCD, 1997), the rangeland degradation is very serious in the arid, semi-arid and dry sub-humid areas of China. The total area of the degraded rangeland is about 105,237,000 ha, accounting for 56.6% of the total area of the rangeland and pastures in the arid, semi-arid and dry sub-humid areas of China. Among the degraded area, areas of slight, medium and severe degraded rangelands account for 53.8%, 32.6% and 13.6%, respectively. Malignant weather conditions such as drought, little precipitation and its uneven distribution, and irrational human activities such as overgrazing are the factors of causing the degradation. From the distribution of the degraded rangeland, the degradation is relatively slight in the east of the arid, semi-arid and dry sub-humid areas of China and is relatively severe in the west. The ratio between the degraded rangeland and the total land in the Alashan Plateau of the west of Inner Mongolia is more than 90%, however, it is about 48% in Xilin Gol Plateau of the mid-east Inner Mongolia (Wang et al., 1998).

Remote sensing can be defined as gaining knowledge about objects or phenomena which are not in directly contacted with the sensors. Remote sensing of the earth by satellite refers to observations and measurements of the energy and polarization of the inherent and reflected radiation of elements of the land, oceans, and atmosphere of the earth in different ranges of electromagnetic waves which are assistance in the describing the location, nature and time variation of natural parameters and phenomena, of natural resources of the earth, of the environment and man-made objects and formation. With the remote sensing technology, the sensed data/image with different spectral, spatial and temporal resolutions are very important for us to dynamically monitor the rangeland resource. Xilin Gol Plateau, located in mid-east of Inner Mongolia, is an important animal husbandry production base both in Inner Mongolia and in China (Chen et al., 1998; IMES, 1988). The main land cover of the plateau is dry steppe. A pilot was selected in the plateau in order to study and better understand the characteristics of the rangeland degradation and reclamation in more than 20 years by using Landsat imagery. This study also developed a system analysis approach for monitoring rangeland desertification in the North China and in the Northwest China.

**2 NATURAL CONDITIONS OF THE PILOT**

The pilot is located at the watersheds of low reach of the Xilin River in the east of the plateau. The 3 images cover from the north latitude from 43° 43' to 45° 29' and the east longitude from 115° 23' to 118° 10'. The Xilin River is an inland river. The main land cover is temperate dry steppe. The major types of grassland are *stipa grandis* rangeland,

*leymus chinensis* rangeland, mixture rangeland of *stipa grandis* and *leymus chinensis*, sparse woods with grasses in the sandy areas, and lowland meadow. Chestnut calcareous soil is widely distributed, sandy soil and meadow soil are also occurred. The plateau has a temperate semi-arid continental monsoon climate. The average annual rainfall is 230~450 mm, with an average of 400 mm. About 70% of the rainfall always comes from July to September. For details, refers to Chen et al. (1998) and IMES (1988).

### 3 SELECTION OF THE IMAGES AND THEIR CLASSIFICATION

Three images are available for the analysis including 1 MSS data and 2 Landsat TM data. They are MSS134/029, 731104; TM124/029, 870730 and TM124/029, 960925. A GPS device was used for positioning when the ground survey was carried out. Growth of the grasses and some soil characteristics were obtained under the guidance of specialists in rangeland management.

ERDAS-Imagine version 8.1, ARC/INFO version 7.0 and Arcview version 3.1 were used in the study. Geometric correction and geo-reference of the images enables the exact overlay of image-on-image that can be carried out by ERDAS, ARC/INFO and Arcview. The standard error for the corrections was less than 1 pixel. Resampling was based on the nearest neighbor method. On the basis of all information the images provided with and the extracted NVDIs, the maximum likelihood classification was used to classify the images into 5 major land use types and their associated land use change types were detected in conjunction with visual interpretation.

High-quality, medium-quality, slight degraded, severe degraded grasslands and others (water bodies, built-up areas) were selected as grading criteria for classifying the region's rangeland because the region has several grass species and soil types. Other reasons for this classification system is to use the CCICCD (1997) classification systems, and better understand degradation and reclamation of the rangeland in more than 20 years. Based on the CCICCD (1997) classification systems, grading criteria of the slight degraded and severe degraded rangelands are:

**Slight degradation:** Plant community composition has not been greatly changed, but individual quantities of different species have been obviously changed. In general, individual quantities of dominant species have been reduced. The species with high palatability and low trample-suffering have been decreased, and consequently the species with low palatability and high trample-suffering have been increased. The fodder yield and vegetation coverage have been declined by up to 30%; and

**Severe degradation:** The most of aboriginal species have been disappeared, and species composition has been simplified in monopoly distribution. The absolute dominant community has been composed of dwarf weeds and trample-resistance bushes; vegetation coverage and fodder palatability have been greatly decreased; grasses community has been sparsely lowed and shortened; coverage and yield of edible fodders have been decreased by more than 30%. Top soil has been exposed and soil salinization has obviously occurred.

### 4 RESULTS AND DISCUSSION

The co-covered area for the 3 images was subset for studying the characteristics of the rangeland degradation and reclamation when the classifications were done. The classified results for the 3 years were shown in figure 1 and the statistical results of their coverages were shown in table 1.

|  |                                      | 1973    | 1987    | 1996    |
|--|--------------------------------------|---------|---------|---------|
| <b>High-quality rangeland</b>              | <b>Area (ha)</b>                     | 673344  | 345188  | 517203  |
|  | <b>Among the total land area (%)</b> | 40.81   | 20.92   | 31.35   |
| <b>Medium-quality rangeland</b>            | <b>Area (ha)</b>                     | 895951  | 892851  | 812860  |
|  | <b>Among the total land area (%)</b> | 54.30   | 54.11   | 49.26   |
| <b>Slight degraded rangeland</b>           | <b>Area (ha)</b>                     | 54655   | 281460  | 219915  |
|  | <b>Among the total land area (%)</b> | 3.31    | 17.06   | 13.33   |
| <b>Severe degraded rangeland</b>           | <b>Area (ha)</b>                     | 20289   | 126595  | 93782   |
|  | <b>Among the total land area (%)</b> | 1.23    | 7.67    | 5.68    |
| <b>Others<br/>(water bodies, built-up)</b> | <b>Area (ha)</b>                     | 5761    | 3906    | 6240    |
|  | <b>Among the total land area (%)</b> | 0.35    | 0.24    | 0.38    |
| <b>The total land area (ha)</b>            |                                      | 1650000 | 1650000 | 1650000 |

Table 1. Area of each classified rangeland in the pilot in 1973, 1987 and 1996

On the coverage of each classified rangeland (table 1), the rangeland degradation was slightest in 1973, and the severe degraded rangeland was caused by soil salinization. The area of the degraded rangeland only just accounted for 4.54% of the total land area, and the areas of high and medium quality rangelands were occupied 40.81% and 54.30% of the total land area, respectively. The rangeland degradation was most serious in 1987, accounting for 24.73% of the total land area, and the slight and severe degraded rangelands occupied 17.06% and 7.67% of the total land area, respectively. The total area of the degraded rangeland in 1996 was relatively decreased compare to that in 1987, but the degraded ratio is still high and is about 19.01%.

On the temporal and spatial distribution of the degraded rangeland (figure 1), the degraded rangeland was distributed near the lakes, swamps and river banks in 1973. However, it extended to a far range from the lakes, swamps and river banks in 1987 with a centralized distribution, and was located in the mid-west part of the pilot. The total area of the degraded rangeland was decreased in 1996, but from view of its distribution, rangeland reclamation was not optimistic. The degraded rangeland was, to some extent, reclaimed in the mid-west part of the pilot, but the rangeland degradation was more serious in the mid-east part of the pilot compared with that in 1987.

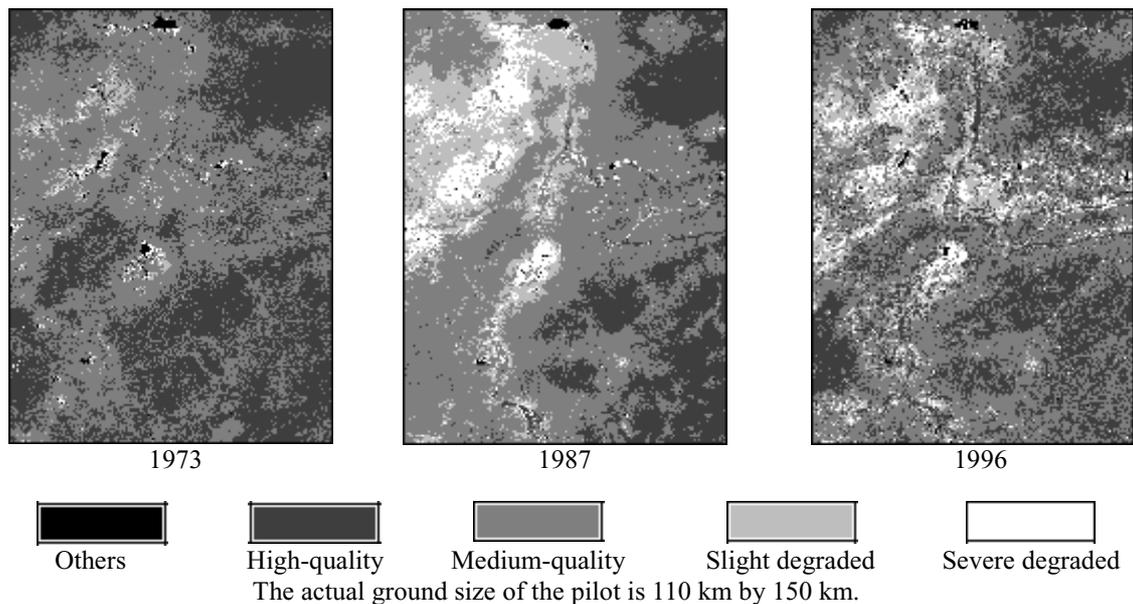


Figure 1. The unsupervised classification results for rangeland of dry steppe in the pilot

As a whole, the rangeland degradation was very serious in 1987, and saline grassland also covered a relatively large area. However, it seemed there was some reclamation in 1996, and the high-quality and medium quality rangelands were distributed in a decentralized pattern (figure 1). This is due to the implementation of the policy of "two rights, one system" in Inner Mongolia from later of 1980's (Anonymous, 1998). Right of owing grassland belongs to ranchers, right of using the grassland also belongs to them, and at the same time landowners have the responsibility of managing grassland at a long duration.

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