

Human dimension of land degradation in Yulin area, China

Wang Changyao and Wang Quan

Institute of Remote Sensing Application, CAS, Beijing 100101, China
Tel: 86 10 6 491 9944 2618; Fax: 86 10 6 491 5035; E-mail: irsaglob@mimi.cnc.ac.cn

ABSTRACT

Arid and semi-arid areas occupy one third of the total area of the world. This vast region is rich in natural resources. In recent times, desertification has become a world-wide phenomenon, due to human activities. China also suffers from this problem. Desertification is especially severe in the south-eastern part of the arid and semi-arid region of the country.

In this paper, the use of remote sensing and geographical information systems for monitoring desertification and environmental change is described and an example is given of how such information can be used for regional planning.

Key words: desertification, GIS, population pressure, remote sensing.

STUDY AREA AND REMOTE SENSING DATA

In order to study the distribution and development of desertification, Yulin County has been selected as a study area. Yulin County is situated in the northern part of Shaanxi Province, middle course of Wuding River and the southern margin of Mao Wusu Desert. The area is 128 km long from east to west and 124 km wide from north to south; a total area of 6945 km². The ancient Great Wall crosses over the region from south-west to north-east and forms a natural dividing line. The county is located at a typical transitional zone between the Mao Wusu desert area, which is suitable for livestock farming, and the northern part of the Loess Plateau, an agricultural area. Concerns about the desert moving southeast-wards have been of great academic interest for a long time. A great shelter afforestation project to control desert expansion has been carried out in the northern part of China since 1976 (see also Xinmin and Xyue-Yong, this issue). Since then, desertification has been reversed in some areas, but in others, desertification has continued to move forward. Therefore, monitoring of the environmental change and regional planning is needed in this region.

The research was done with the aid of remote sensing data such as Landsat TM and SPOT images, and color infrared aerial photographs (CIR).

ANALYSIS OF DESERTIFIED LAND DISTRIBUTION USING GEOGRAPHICAL INFORMATION

Data on the varieties of desertification types can be obtained using image processing system to classify Landsat TM and SPOT XS data. However, the precision of automatic image classification is influenced by the complexity of natural factors. In order to improve the accuracy of the image classification, image processing was combined with the use of geographical information systems (GIS).

Distribution pattern of desertified lands

A desertification map for the area was made with image processing and classification data, and topographic maps (with elevation and river system data) which were entered into the database by digitizing. These maps were combined in the GIS database (Arc/Info). The desertified lands distribution map obtained from this GIS-system shows that desertified lands are mostly distributed along banks of the Yuxi River, the Wudao River, and the Hailiutu River. The results show that the total area of deserti-

fied land of Yulin County is about 4678 km² which is about 67% of the whole territory. The data indicates therefore that the desertification problem is very severe in Yulin County. A key region in relation to desertification is located along the ancient Great Wall.

In order to analyze the distribution pattern of desertified lands, the “Buffer” program of the Arc/Info was used. The width of the buffer zones was selected as 1, 5, 10, and 15 km along the main rivers of the study area. Analyzing the buffer file, the percentage of each desertification type could be related to buffer distances. However, moderate, slight, and latent desertified land types occupied a small proportion of their respective total area. Within the zone between 1 and 5 km, the area of intensive desertified land takes up about 60% of the total area of this type. So, it was shown that intensive desertified lands within 5 km wide zone along rivers take up about 81% of the total area of this type, which indicates that intensive desertified lands are mainly distributed in this zone. It is also found that 90% of moderate, slight, and latent types of desertified lands are concentrated within a range of 5–15 km along rivers. These results show that man first conducted land resource exploitation along river banks with better natural conditions. Furthermore, they continued to farm grasslands close to the river banks with fragile eco-environment. So that the intensive desertification has taken place in this region. The conclusion drawn from the above is opposite to general opinion that the farther away it is from rivers, the more intensive is the desertification. This conclusion is very valuable to analyze deserted land pattern and to make regional harnessing and planning decisions.

Desertification monitoring

Remote sensing data from three dates, 1960, 1987, and 1992, were selected to conduct comparative analysis for monitoring desertification development. The GIS-system was used to compare the three desert distribution maps. The results are shown in Table 1.

Table 1. Desert area statistics (%) of the Yulin County from three different dates.

Type	1960	1987	1992
Shifting sand	35.3	21.6	19.4
Semi-fixed sand	15.1	18.8	21.2
Fixed sand	7.6	26.8	24.6
Total	58.0	67.4	65.2

According to Table 1, desertification area in the Yulin County in 1992 is smaller than that of 1987, and is 7% larger than in 1960. This shows that large-scale cultivation had taken place at this site since the 1970's and vegetation cover had not recovered to the 1960 level, although over-cultivation activity has been restricted lately.

ANALYSIS OF LAND DESERTIFICATION CAUSES

The Yulin study area is located at a typical semi-arid temperate steppe zone with an annual precipitation of over 400 mm. Therefore, land desertification should not have been caused in this region. Historical documents show that there used to be extensive grasslands in the northern Yulin County and dense forests in the southern part, an area with plenty of water and lush grass 2000 years ago (She Hianhei 1981).

The reasons for the relative serious desertification are the impact of human activities, with the exception of natural factors including dry climate and loose land surface materials liable to be weathered.

Single agriculture economy and long-term over-cultivation

There was a sparse human population in the Yulin County before the Tang Dynasty, and people were mainly engaged in animal husbandry. However, after Tang Dynasty (618 AD) because of chaos caused by severe war, a large number of poor peasants came here from the south of the region to farm the wasteland to meet the demand for food supply. The vast grassland and forest land was destroyed and the land desertification developed progressively (She Hianhei 1981). Since then, the single agricultural economy has been carried out. As a result, the human induced vegetation destruction is gradually increased, land desertification is more and more serious, and the eco-environment has become very fragile in the region. The phenomenon does not only violate the desertification rule in the normal geographical zone, but also in the abnormal geographical zone. It illustrates that, although the natural elements have had little change, human activities are the main reason to cause the desertification development.

In order to study the reason for the desertification expansion, the present land use structure and land resources were analyzed. The results indicate that present land use structure is irrational. Based on the analysis mentioned above, it can be concluded that one of the most important reason for land desertification in the region is the destruction of forests and grassland farming.

Low forest coverage, overgrazing and grassland degradation

The coverage of forests and grass is very low. The statistical results show that in 1949, the coverage of forests were only 1.8% in the region. Since 1976, large scale tree and grass planting activities were carried out along with the implementation of "Forest Shelter of Northern Part of China" engineering project, but the survival rate of the trees planted is very low and the quality of forests is poor. Before 1977, the survival rate of the trees planted was only 25% and from 1979 to 1981, the survival rate of the trees planted only reached 50% in the Yulin County (Yang Zhongxin 1984).

Vegetation Index model using Landsat TM and field sample measurements was generated during the grassland quality investigation. In general, the yield of fresh grass is about 3000 kg/ha. Comparing with the 1950's, the yield of fresh grass decreased by 40–60% in sand area and decreased by 30–50% in hilly area in the southeast Yulin County. Edible grass has declined and weeds and poisonous plants have increased, which indicates that the grassland was greatly degraded. However, artificial grassland has developed slowly and the area of artificial grassland was less than 10% of the total grassland areas of the county in 1987. Meanwhile, because of the irrational management practices and overgrazing from 1949–1982, the available grassland per sheep unit decreased gradually (Ren Zhibi 1990). Overgrazing is not only limited to the growth of livestock and decreased grassland productivity, but also grassland degradation and desertification.

Population increase

Local statistical data for the Yulin County shows that the population increased by 250% from 1949 to 1982. The population density rose from 18 pers./km² in 1949 to 43 pers./km² in 1982 (He Peizheng 1988). The farmland available for each person decreased by about 100%.

A critical index of population pressure in different zones was provided during the Conference of Arid Land Resources and Environment in 1977. The critical index of population pressure was considered 20 pers./km² in semi-arid zone, humid coefficient 0.2–0.5.

At present, the population density of Yulin County has exceeded this critical index. From now on, if population increases by a rate of 8.5% annually, the total population of Yulin County will increase by 39% in 2000. Farmland per capita will decrease gradually. If forest damage and grassland to farmland changes increase together with the population, land desertification will become more and more serious.

CONCLUSION

This study demonstrates that remote sensing technology and geographical information systems can play a great role in land desertification investigation, monitoring land changes, and as a tool for regional planning. If the multi-temporal remote sensing data at optimum season are acquired, it is possible to establish a desertification analysis model to study the cause of land desertification and predict the trend of its expansion quantitatively.

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