Vegetation coverage change in Miyun County and its affecting factors based on 3S

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KEY WORDS GIS; land cover; land use; vegetation; detection

ABSTRACT

Vegetation index is one of the important parameters describing the land cover characters while remote sensing is generally used in getting regional vegetation index. In this article TM remote sensing data is used to acquire vegetation coverage of Miyun County with *NDVI* as one parameter in 1991 and 1997 respectively. It indicates that the average vegetation fractional coverage in Miyun County decreases in 1970s, from 53.46% to 51.59%, the effective vegetation coverage decreases from 23.89% to 15.54%. Besides the effect of natural factors such as temperature and precipitation, the effect of human activities on the change of land use structure is the main reason. As a result, the area of grassland and farmland decreases and the area of unused land increases while the former decreases by 15.80% and 2.87% respectively the latter increases by 5.35%. It is very important to keep and make full use of grassland and strengthening the management of unused land.

1 INTRODUCTION

Land use/cover change (LUCC) is the change of land surface caused by human activity on land use. Land use/cover change (LUCC) is one of the main ideas in global change research and important in regional ecology construction (Zhang Y.X., 2003; Li X.B., 1999). Vegetation fractional coverage is a sign for justifying regional ecological environment and increased vegetation fractional coverage plays an important part in ecology recovery and environmental construction (Li X.B. 1996). Change of land use types and land use structure is a main direct reason for that change and it is guidable for regional land plan to analyze this change. Miyun County, sit in north-east Beijing, is an important natural ecological area and water supply protection area. Sited in the middle of Beijing, Miyun reservoir is the only drinking water source in Beijing. As a result, the dynamic change of vegetation fractional cover and analysis of its driven reason become the important reason for making land use plan and ecological environmental utilization. Vegetation index is the important parameter for describing regional vegetation fractional coverage and can be acquired by remote sensing technology. We choose Normalized difference vegetation index (NDVI) to get vegetation fractional coverage with remote sensing data. Analysis of dynamic change of vegetation fractional coverage in Miyun County in 1990s to utilize land use structure in study area and protect soil from being taken away and protect water.

2 STUDY AREA

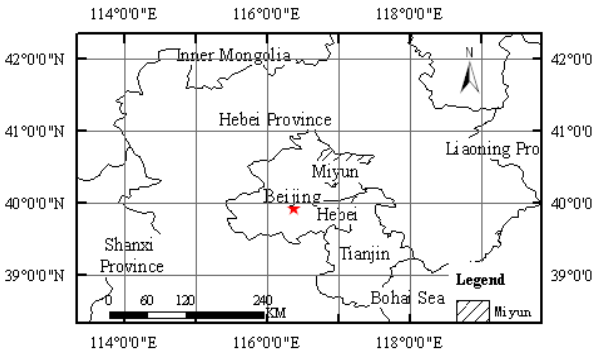

Figure 1. Study area

Miyun County seats in north-east Beijing, longitude between 116°41′ and 117°30′, latitude between 40°14′ and 40°48′. Its border is around with Xinglong, Chengde, Luanping of Hebei province in eastern and northern Beijing, Huairou in west and Shunyi and Pinggu in south (Figure 1.). The area of Miyun

County is the biggest compared to the other cities in Beijing, with a total land area of 2 230 000hm^2 and total population of 4 180 000.

Miyun County lies in climate transitional zone between humid monsoon area and arid inland area, belonging to semi-humid continental monsoon climate with a climate of obviously different four seasons, winter dry and cold, summer warm and wet. Average yearly temperature 10.8 ℃, hampered by northern mountain, shows a piedmont warmer climate, with a higher temperature than the area in the same latitude. Distribution of precipitation within a year is uneven and precipitation with great variations from year to year is unstable. The average annual precipitation is about 675 mm, most of which falling in summer. Study area is placed in the transitional zone between Yanshan Mountains and North China Plain, where its terrain inclines from northeast to southwest, high in east and west. There are also downfaulted basins in the middle and aggradated plain in southwest forming dust pan shape with mountains around in three sides, low in middle and open in southwest. The terrain is step-shaped and relative height difference is large, cut slopes are deep with thin soil leading to severe soil and water loss. Miyun reservoir seated on mountains in the middle of Miyun County, taking the mission of supplying water for agricultural and industrial use and life use in Beijing, Tianjin and part of Hebei province.

3 STUDY METHODS

3.1 Data source and pretreatment

TM remote sensing data, 1:1000 000 topographic map, Land Use Map of Beijing, Vegetation Map of Beijing and social economical statistical data and so on are used in this study. The resolution of TM data is 30 m.TM data has an atmospheric correction, radiometric correction and geometrically rectified with quadratic polynomial and bilinear interpolation. Empirical error is controlled in one pixel. The phrases of the two images are May in 1991 and May in 1997 respectively, when vegetation is growing faster and vigorously and can reflect the covering situation of the local vegetation (Li M.M., 2004). The image is clear without cloud in the edge of city and country. The two image phases are consistent so that it is exact to extract effective information of land use change.

3.2 Extraction of Normalized Difference Vegetation Index:

In radiative spectral curve of the typical vegetation, there is one chlorophyll absorption belt (Center around 0.45μm and 0.65μm). There is one also strong reflection peaks in near infrared region, the two completely different characteristics of the affection of vegetation on visible light and near infrared radiation is caused by pigments and internal organization of a cell, Normalized Difference Vegetation Index is acquired by this difference and used effectively in vegetation detection. For Landsat TM data, band 3 as CH3 in absorption band of chlorophyll and band 4 as CH4 in spectrum reflection region. NDVI can be calculated by following formula (Li X.B., 2003; Gutman G., 1998).

$$NDVI = \frac{CH4 - CH3}{CH4 + CH3}$$

Where, CH3 stands for the 3rd reflecting value of the TM image, CH4 stands for the 4rd reflecting value of the TM image.

3.3 Estimation of vegetation cover fraction

Vegetation grows rigorously in May, study area is covered with vegetation-covered district such as forest land, grassland and farmland and non-vegetation covered district such as bared land and water (Chen Y.H., 2001). Gutman model is chosen in this article to acquire vegetation fraction according to the relationship between vegetation fraction and NDVI (Zhao Y,S., 2003; Sun J.H., 2007). Formula is as follows,

$$f = \frac{NDVI - NDVI_{\min}}{NDVI_{\max} - NDVI_{\min}}$$

Where, NDVI is the normalized difference vegetation index of the pixel obtained. $NDVI_{min}$, NDVImax are non-vegetation region and vegetation-covered region.

3.4 Grades of vegetation cover fraction

According to Criterion of Classification of Soil Erosion in 1996, vegetation fraction is divided into 5 grades, which stands for very low cover area, low cover area, middle cover area, middle-high cover area and high cover area. The criteria is as

follows, Grade 1 has a vegetation fraction less than 10%; Grade 2 10%-30%; Grade 3 30%-50%; Grade 4 50%-70% and Grade 5 above 70%(Lu Z.Z., 2001; Cai T.J., 2005).

3.5 Remote sensing interpretation of land use types

Land use type in Miyun is divided into 6 grades, forest land, grassland, farmland, urban land, water and unused land respectively (Liu B.R., 2005; Lu Y.D., 2005; He C.Y., 2001). Band 4, 3 and 2 of TM image are combined to identify vegetation. Erdas 8.7 is used to get land use type map of Miyun County in 1990.

4 RESULTS AND ANALYSIS

4.1 Vegetation Fractional Coverage

Figure 3 shows the different characters of vegetation coverage of Miyun County in 1991 and 1997. The average vegetation coverage reduces from 53.46% to 51.59 % in this area in 1990s. Table 2 shows area for different vegetation coverage of Miyun County in 1991 and 1997 respectively. The very low vegetation coverage area, low vegetation coverage area, middle vegetation coverage area , middle-high vegetation coverage area and high vegetation coverage area are accounted for 0.03%, 2.89%, 53.71%, 23.89% and 19.48% of Miyun County area in 1991 respectively, and are 0.34%、3.52%、56.39%、15.54% and 24.22% in 1997 respectively(Table 2.). The results show that the very low vegetation coverage area, low vegetation coverage area, middle vegetation coverage area and high vegetation coverage area increases, especially middle vegetation area and high vegetation area, increased significantly 2.68% and 4.74% respectively. The middle-high vegetation coverage area reduces significantly 8.53% and effective vegetation coverage also reduces, from 23.89% to 15.54%.

Table 2. Area for different vegetation coverage of Miyun County in 1991 and 1997

Types of vegetation cover	Area in 1991（S_1）（10 000hm^2）	Area in 1997（S_2）（10 000hm^2）	Change（S_2-S_1）（10 000hm^2）	Rate of change（S_2-S_1）/S（%）	Annual rate of change（%）
Extremely low coverage	13.07	148.10	135.03	+0.31	+0.05
Low coverage	1 271.95	1 546.38	274.43	+0.63	+0.11
Middle coverage	23 622.59	24 803.06	1 180.47	+2.68	+0.45
Middle-high coverage	10 506.67	6 834.56	-3 672.11	-8.35	-1.39
High coverage	8 568.25	10 650.42	2 082.17	+4.74	+0.79

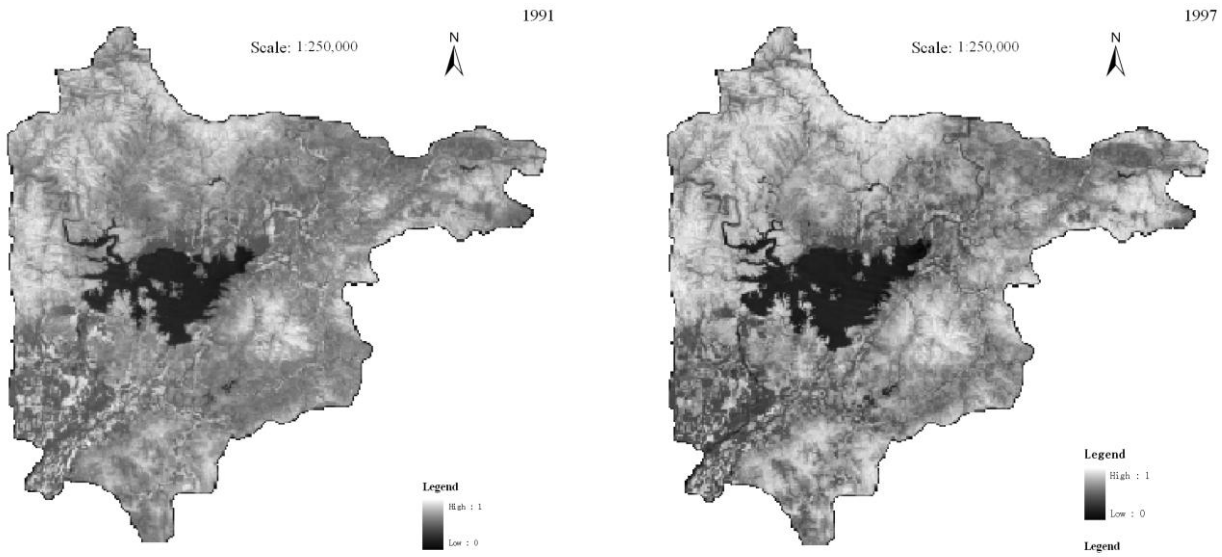

Figure 3. Map of vegetation coverage of Miyun County in 1991 and 1997

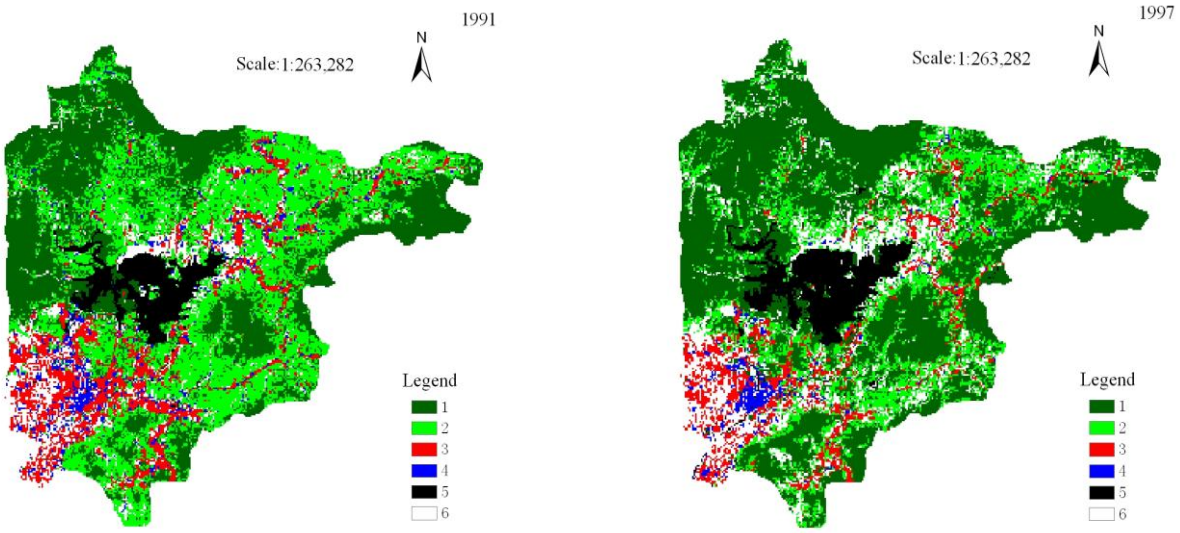

Figure 4. Land use types in 1991 and 1997

Notes: 1 stands for forest, 2 stands for grassland, 3 stands for farmland,

4 stands for land for urban and rural citizen, 5 stands for water and 6 stands for unused land

4.2 Land Use Types and Structure

Figure 4 shows the different distributions of land use types of Miyun County in 1991 and 1997. The main land use types of Miyun County are forest land and grassland, and the area of the two types is more than 50% of the total area of Miyun county (Dang A.R., 2003; Zhang H.B., 2007). The distribution configuration of land use type is different. Forest land and water show flake distribution. Cultivated land, grassland and unutilized land show mutual nested distribution. Cultivated land is distributed in the southwest mainly, and show zonal distribution along Miyun water system towards east and northeast. Forest land is mainly distributed in the northwest mountain, and the rest distributes in west mountain area. Grassland is mainly distributed in the southern and northern parts of Miyun reservoir, which shows zonal distribution along cultivated land. Urban land is mainly located in center county town. Water consists of Miyun reservoir and its tributary water system. Unutilized land including urban and rural building site, idle cultivated land and bare land, is distributed mainly in southwest urban and northern side of Miyun reservoir. Of the land use types, forest land, water and unutilized land show increasing trend, while cultivated land, grassland, urban and rural residents land show decreasing trend. Forest land increases mostly from 31.5% of the total area in 1991 to 47.81% in 1997, and the scale is about 16.31%. Water area increases 2% approximately. Unutilized land increase 5.34% approximately. The percentage of grassland is about to 15.80%, decreased most from the 35.56% of the total area in 1991 to 19.76% in 1997. Cultivated land decrease 3% approximately. Urban and rural residents decrease 1.62% (Figure 4). From the magnitude of change area, it happens mostly in forest land and grassland secondarily. Cultivated land and unutilized land change subsequently. The change degree of water and urban and rural residents was the least.

4.3 The analysis of driving factors of vegetation coverage change

Climate is the direct natural factors affecting vegetation coverage change in Miyun County, and especially precipitation, is the primary influencing factor. According to the statistics, temperature is also the same but precipitation is reduced during 1991 to 1997, especially in summer every year. The land use types and pattern changes that were affected by extremely frequent human activity is one of influencing factors. The decreasing area of Grassland and the increasing area of unutilized land are mainly influencing factors of vegetation coverage reduction in Miyun County in 1990s. Figure 4 indicates that there are large-area grass growing in 1991 but the area of grassland reduces significantly in 1997 and is substituted by large-area forest along two sides of river.

Unutilized land increases 5.35% especially in the southwest county which is consisted of bare land, urban building site and idle cultivated land. The county town, the regional of high population and frequent activities, is changed rapidly because human activities have directly influence on vegetation status.

5 CONCLUSION AND DISSCUSSION

(1) Vegetation fractional coverage of Miyun county indicates a decreasing trend, reducing from 53.46% to 51.59% in 1990s and effective vegetation fractional coverage is 23.89% from 15.54%. According to research results, the rate of soil erosion is far more rapid than that of soil formation given that a certain place that the vegetation coverage is under 50%, while the soil erosion will not happen and not be influenced by topography effect where the vegetation coverage is above 75%. In brief, the effective vegetation coverage should be in the range of 50% and 75%. The more it decreases, the faster the rate of soil erosion, and the growth of forest and grassland will have a positive effect on vegetation coverage. In conclusion, the percentage of above two land use types should be appropriately risen.

(2) From the perspective of land use, the major cause of the reducing vegetation coverage in Miyun is resulted from the decreasing grassland area and the growth of unutilized land. With the booming economy in Miyun through the development of tourism, the demand of building site rises and is responsible for generation of unutilized land. Take house construction for example, the constructing area is soaring from 40.9hm^2 in 1996 to 61.4 hm^2 in 1997. Moreover, during the course of city construction, it wastes parts of cultivated land leading to the reduction of cultivated land. Comprehensive management engineering of small watershed and debris flow hazard projects have promoted surface formation and geomorphology, effectively making soil erosion under control and attaining the goal of water conservation, some grassland substituted by forest leading to grassland decreasing (Liu L., 2005). Thus, with the aim of land readjustment planning, in addition to strength afforestration, it is of vital importance in preserving and utilizing grassland properly, increasing the management of unutilized land including construction land, to achieve social and economical benefits greatly, which is established on the foundation of optimizing land use patterns with limited resources and using finite land resources reasonably.

ACKNOWLEGEMENTS

This study was supported by Trans-Century Training Program Foundation for the Talents Ministry of Education of China (NCET-04-0149) and National Natural Science Foundation of China (30670398).

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