Study on the Variation of Vegetation in Shenyang City Based on MODIS Data

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Abstract— The distribution characteristics and interannual variation of vegetation in Shenyang city from 2001 to 2011 were analyzed according to vegetation index products MOD13A3 from MODIS. The results showed that the vegetation density increased gradually from the city center to the periphery, the overall trend of vegetation variation in whole city was degraded from 2001 to 2011, the vegetation around the outskirt of town were degraded slightly or seriously in different regions and at different periods, the vegetation in the town and in the periphery areas of Shenyang were gradually ameliorated more or less. The natural factors had certain influence on vegetation variation, but the main effect was still the influence of artificial factors including urban expansion and urban greening.

1. INTRODUCE

Vegetation is a natural bond which links soil and atmospheric and one of the important indicators for regional ecosystem environmental changes [1]. It is of great significance that the information and variation of vegetation be obtained accurately for analyzing the influence of human activities on the natural ecological environment. At present, vegetation index has played a very important role in many research fields such as the classification of vegetation, crop yield estimation, global and regional land using, land cover variation, and so on. Meanwhile, vegetation index has provided timely and effective information service for the environmental monitoring, agricultural, forestry, and other relevant departments. Foreign scholars has studied the vegetation information through the vegetation indices earlier and made many achievements [2–4]. Vegetations were classified by Nemani [5] according to seasonal variation characteristics of vegetation indices and the temperature of plant surfaces based on NOAA/AVHRR data [5]. Stow et al. found the trend of vegetation green in northern Alaska area by extracting SINDVI using AVHRR LAC data at a resolution of 1 km in 1990 and 1999 [6].

Civil Sheng Yongwei et al. used dynamic method to classify the vegetation in our country according to the characteristics of NDVI in time series, by using the NDVI data at 6 km spatial resolution from meteorological satellite [7]. The characteristics of vegetation distribution and vegetation interannual variation in Shenyang from 2001 to 2011 were studied by using MODIS-NDVI data in this paper.

2. DATA AND PROCESSING

2.1. Investigation Area

Shenyang city locates in the middle of Liaohe plain in Liaoning province, it is divided into five districts, Heping, Shenhe, Huanggu, Dadong, Tiexi, and five outskirts, Dongling, Hunnan, Yuhong, Sujiatun, Shenbei. Shenyang region is temperate continental monsoon climate with four distinct seasons. It's cold and dry in winter, wet and rainy in summer, rapidly changing temperature in spring and autumn, windy in spring, sunny in autumn.

Shenyang's midsummer is around the middle of August. In this time, vegetation grows the most densely, vegetation index achieves year-round maximum and is the most representative for vegetation growth information. So the maximum of NDVI in August was chosen to study the characteristics of vegetation distribution and variation in Shenyang from 2001 to 2011.

2.2. Data

The terrestrial vegetation index products (MOD13A3) come from NASA Earth Observation System (EOS) which contain two kinds of vegetation index: NDVI and EVI at a time resolution of the month and a space resolution of 1 km. According to the characteristics of NDVI which shows more sensitive in middle and lower vegetation coverage area and the relatively smaller vegetation

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coverage [8], MODIS-NDVI was used to describe the information of vegetation in Shenyang in this study.

2.3. Data Processing

Through image projection conversion, subsetting, mosaicing, stacking and other steps, NDVI data in Shenyang were acquired. The vegetation coverage variations from 2002 to 2011 were acquired by NDVI data in August in 2001 respectively subtracting from the data in August from 2002 to 2011.

3. VARIATIONS AND DISTRIBUTION OF VEGETATION

3.1. Distribution Characteristics of Vegetation

NDVI data in 2002, 2005, 2008 and 2011 were chosen to analyze the distribution of the vegetation in Shenyang. Figure 1 showed the vegetation coverage increased from the vegetation density increased gradually from the city center to the periphery. The high vegetation density mainly distributed in farmland and woodland surrounding the town. The denser vegetation coverage area made up bigger proportion of city. Low vegetation coverage area, moderate vegetation coverage area and dense vegetation coverage area had smaller proportions. Low vegetation coverage area mainly distributed in the town.

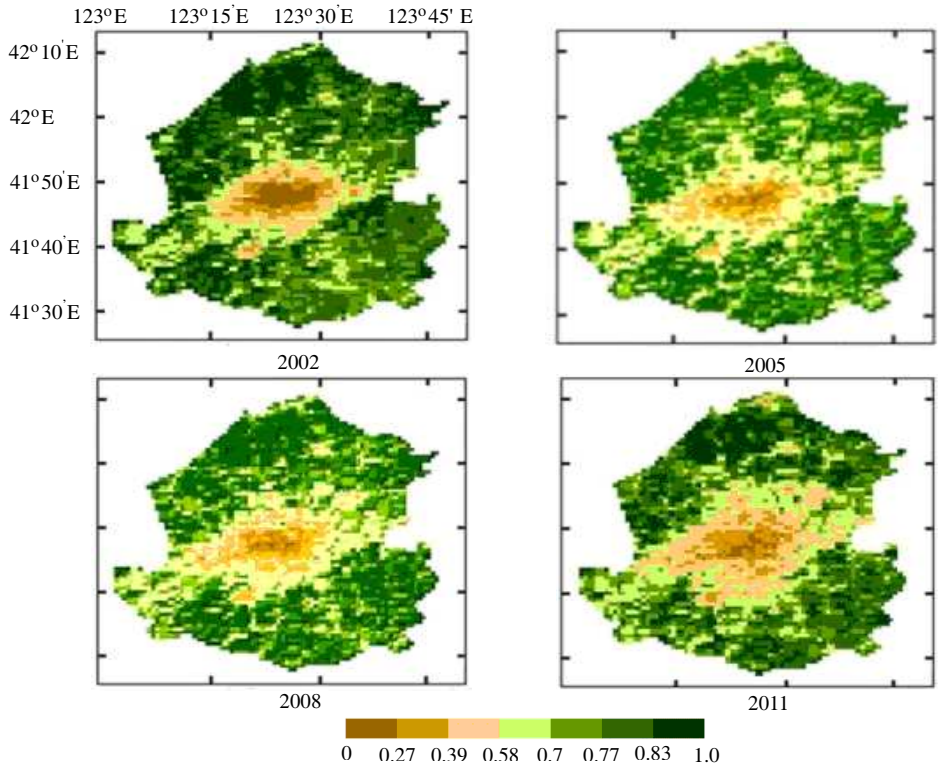

Figure 1: Maps of NDVI distribution in Shenyang from 2001 to 2011.

3.2. Statistics Characteristics of Vegetation Variation

Figure 2 was the line chart about the average of NDVI in August from 2001 to 2011 in Shenyang, it reflected the mean vegetation coverage and showed that vegetation coverage reduced gradually.

The vegetation coverage maintained at a high level in 2001 $\sim$ 2004, the values of NDVI were between 0.73 and 0.74. The vegetation coverage obviously reduced in 2005 $\sim$ 2007 (the values of NDVI were between 0.7 and 0.715) and reached the minimum in 2006. The vegetation coverage restored to the level before 2004 in 2008. The values of NDVI reached the minimum again as 2006 in 2009. The vegetation had a slight improvement in 2010 $\sim$ 2011, the mean of NDVI maintained between 0.72 and 0.75.

The classification standard of vegetation coverage variation was shown in Table 1 [9]. According to the standard, vegetation coverage variation from 2001 to 2011 was classified into eight levels. The percentage of each classification was also counted in Figure 3.

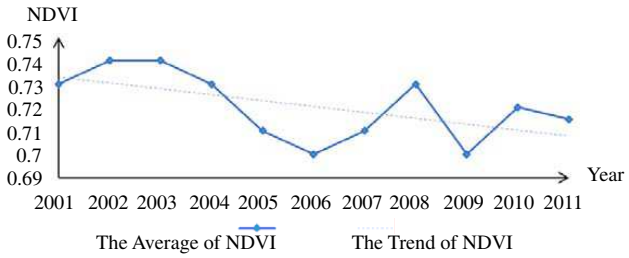

Figure 2: Average of NDVI in Shenyang in august from 2001 to 2011.

Table 1: Classification standards of vegetation variation.

NDVI variation range (X)	description	[legend]	NDVI variation range (X)	description	[legend]
$X<-0.3$	significant degradation	[ ]	$0\le X<0.1$	slight improvement	[ ]
$-0.3\le X<-0.2$	obvious degradation	[ ]	$0.1\le X<0.2$	moderate improvement	[ ]
$-0.2\le X<-0.1$	moderate degradation	[ ]	$0.2\le X<0.3$	obvious improvement	[ ]
$-0.1\le X<0$	slight degradation	[ ]	$X\ge 0.3$	significant improvement	[ ]

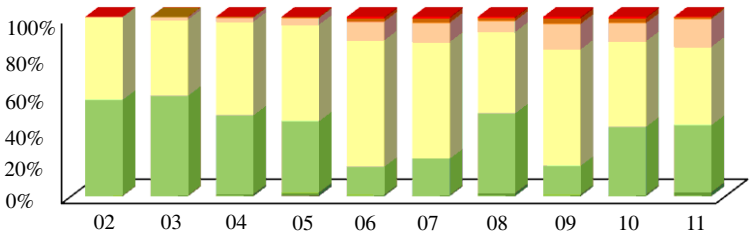

Figure 3: Percentage in column of vegetation variation relative to 2001 from 2002 to 2011 (legend in Table 1).

3.3. Regional Distribution Characteristics of Vegetation Variation

The classification maps of vegetation variation from 2002 to 2011 were made. For convenience, only the maps of vegetation variation in 2002, 2005, 2008 and 2011 were listed to explain the characteristics of the vegetation variation in Shenyang (Figure 4). The maps showed that: in 2002, the vegetation varied slightly, mainly concentrated in the outskirt of town in a mild and moderate degradation; in 2005, the vegetation variation around the outskirt of town was obvious in a moderate and obvious degradation. the vegetation degradation area in the west was larger and was in an obvious degradation; in 2008, the vegetation degeneration area around the outskirt of town and the vegetation degeneration area in the west continued to increase, the degradation was more serious; in 2011, the vegetation degradation in the west stopped, but the vegetation degradation developed fast in the north, the east and the south, and was in an obvious degradation; the vegetation in the town and in the south of the city had been improving from 2001 to 2011, and the improvement of the vegetation in 2011 was in an obvious improvement.

3.4. Causes of Vegetation Variation

3.4.1. Natural Factors

Vegetation growth is affected by natural conditions such as precipitation, temperature and so on. Only the effect of precipitation on vegetation was analyzed. The precipitation in Shenyang from 2001 to 2011 was provided by Shenyang Bureau of Meteorology and was shown as Figure 5 with the average of NDVI. It can be deduced from the line chart of precipitation and NDVI that precipitation and NDVI had little correlation which showed precipitation slightly impacted on vegetation.

3.4.2. Human Factors

The effects of human factors on vegetation were mainly artificial planting, cultivation, felling, etc. That the town has been expanding outwards is consistent with which vegetation has kept in degradation around the outskirt of town. That human habitat of Shenyang gathered to Tiexi

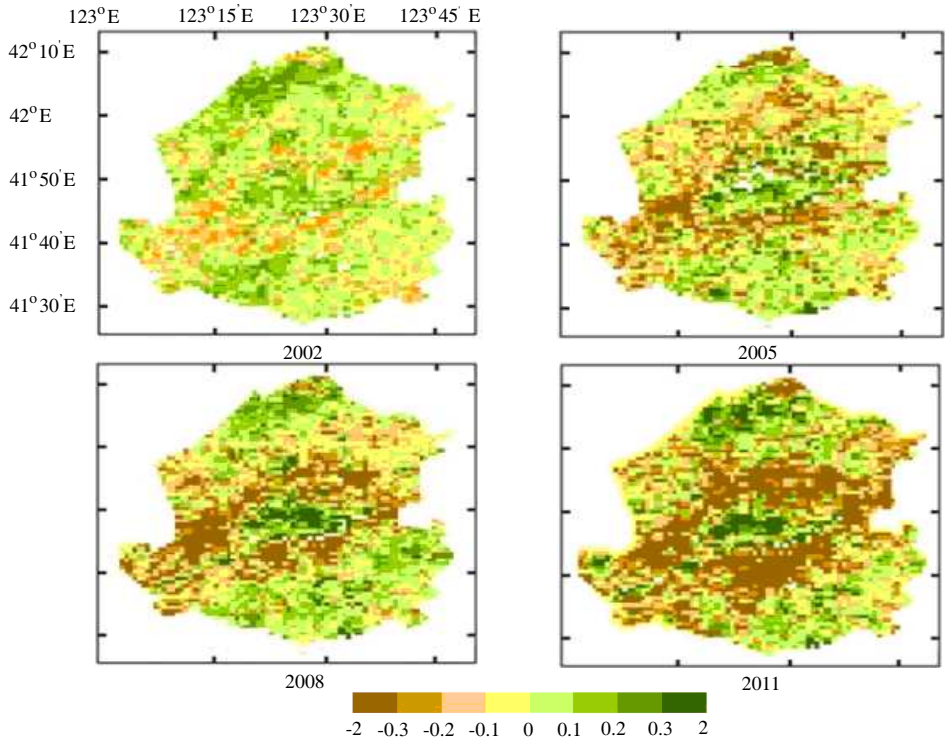

Figure 4: Maps of vegetation variation relative to 2001 from 2002 to 2011.

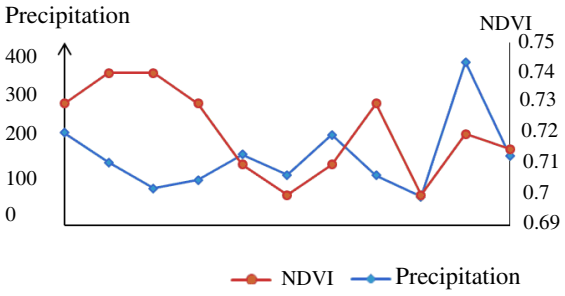

Figure 5: Precipitation and average of NDVI in Shenyang from 2001 to 2011.

District from 2000 and that Tiexi District had become living areas led to a continuous degradation of vegetation.

In 2008, the infrastructure of Tiexi District was basically finished and the urban construction developed to Hunnan District and Shenbei District, it was reflected that the vegetation in these regions began to decline.

4. CONCLUSIONS

The distribution and variation characteristics of vegetation in Shenyang city were analyzed by using NDVI data of MODIS sensor from Terra satellite. It was concluded that the vegetation density increased gradually from the city center to periphery; the overall vegetation in Shenyang showed a trend of deterioration from 2001 to 2011; Natural factors had slightly effect on vegetation variation, the main influence were human factors, the urban expansion led to the vegetation be destroyed around the outskirt of town, under the government's initiative in recent years, vegetation coverage in town was increasing gradually, but the density was not high yet.

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