ISSN: 1813-4890

Temporal and Spatial Variation of Vegetation Coverage in Yulin City under the Background of Ecological Engineering

Liangyan Yang[1,2,3], Hui Kong[1,2,3]

[1] Shaanxi Provincial Land Engineering Construction Group Co., Ltd, Xi'an 710075, China;

[2] Shaanxi land Engineering Technology Research Institute Co., Ltd., Xi'an 710021, China

[3] Key Laboratory of Degraded and Unused Land Consolidation Engineering, the Ministry of Natural Resources, Xi'an 710021, China

Abstract

Based on MODIS remote sensing data, the linear regression slope method was used to analyze the vegetation change at the pixel scale for the NDVI of Yulin City. From 2000 to 2009 and from 2010 to 2019, the velocity of vegetation index change in Yulin City was quite different. The average slope of the former was 0.013 1/a, and the latter was 0.007 8/a. In terms of spatial distribution, the degraded areas from 2000 to 2009 were mainly distributed in the western mountainous areas and the edge of the Mu Us Sandy Land, and the degraded areas from 2010 to 2019 were mainly distributed in the urban periphery of Yuyang District and the fringes of other towns. The linear regression slope method is more suitable for the study of long-term vegetation dynamic changes, which can comprehensively consider the process and results of changes, and has good applicability.

Keywords

NDVI; MODIS; Temporal and Spatial Variation; Yulin City.

1. Introduction

Vegetation plays an important role in the water cycle and energy conversion as a link between the energy exchange, water cycle and biological cycle process between the earth and the atmosphere [1-2]. The spatial distribution of vegetation can reflect the regional temporal and spatial distribution of soil moisture, shallow groundwater depth and air temperature [3]. At the same time, the temporal and spatial changes of vegetation will also cause changes in parameters such as surface temperature and surface albedo [4], thereby affecting the balance of surface energy and water volume [5]. In addition, the vegetation ecosystem in arid areas is extremely sensitive to climate change. Exploring the process of vegetation change can provide an important basis for climate change research. Therefore, studying the temporal and spatial distribution characteristics of vegetation in different regions and its influencing factors is the main content of current research on global climate change.

With the rapid development of remote sensing technology, it has provided abundant data sources and new technologies for macroscopic and long-term monitoring of the dynamic changes of vegetation. Among them, MODIS data has the characteristics of high temporal resolution, abundant data products, and free access, etc., and has obvious advantages for exploring the changes of vegetation and water and heat in regional-scale long-term series. The normalized vegetation index (NDVI) based on remote sensing data can better reflect the surface land cover type, vegetation growth status, vegetation biomass, etc., and is widely used to monitor the dynamics of land use and vegetation coverage at regional and global scales. Variety. In recent years, there have been many domestic studies on the temporal and spatial distribution of vegetation and the restoration of the ecological environment in the northwest arid region [6-7]. For different study areas, different satellite data have been used to quantitatively analyze the regional vegetation ecological environment. Scholars use long-time series data to study the temporal and spatial dynamic changes of vegetation in Yulin City and explore the response relationship between vegetation and water and heat conditions, which is difficult to provide reliable support for the sustainable development of the ecological environment in northern Shaanxi. Based on the MODIS vegetation index data from 2000 to 2019, this study analyzed the spatiotemporal distribution pattern and seasonal dynamic change characteristics of the vegetation index in Yulin City by using the maximum value synthesis method and the linear regression slope method. Healthy development provides the basis.

2. Overview of the Study Area

Yulin City is located in the northern part of Shaanxi Province. The study area is located in a semi-arid area, which is dry and water-deficient, and the ecological environment is fragile. The northern part belongs to the junction of the Loess Plateau and the southern margin of the Mu Us Sandy Land, and is mostly denuded dunes and grasslands between hills; the southern part is located in the center of the Loess Plateau, with hilly and gully landforms and serious soil erosion. The average altitude in the study area is 1 200 m, the average annual temperature is about 10.1 °C, and the average annual precipitation is 350-550 mm. The precipitation is uneven for many years, and the seasonal changes are large. Among them, July to September is the rainy season, which has a typical semi-arid climate characteristic.

3. Data Sources and Research Methods

3.1. Data Sources and Processing

This paper selects the NDVI data of the growing season in Yulin City from April to October. The data comes from the MODIS 16-day synthetic data synthesized by the NASA (https://ladsweb. modaps.eosdis.nasa.gov/search/), a total of 280 images, the row and column number are h26v05, the spatial resolution is 500 m, and the temporal resolution is 16 days. Two phases of images can be obtained every month, and the maximum value of the two is taken as the vegetation index of the month. Use ENVI5.3 software to convert HDF format to TIFF format data, and perform projection conversion and area cropping and splicing.

3.2. Research Methods

In order to study the change trend of vegetation cover in Yulin City from 2000 to 2019 and its response relationship with water and heat conditions, the linear regression slope method was used in this paper to simulate the change trend of the annual NDVI value of each pixel, and to analyze the temporal and spatial change law of vegetation during the study period. Calculate the pixel regression slope of the normalized vegetation index sequence and time series. If the slope is positive, it means that the vegetation coverage is increasing with time; if it is negative, it means that the vegetation coverage is decreasing with time, and the absolute value of the slope is higher. The larger the value, the more obvious the change in vegetation coverage. Its calculation formula is:

$$\mathrm{Slope}=\frac{n^{*}\sum_{i=1}^{n} i^{*}\mathrm{NDVI}_i-\sum_{i=1}^{n} i\sum_{i=1}^{n}\mathrm{NDVI}_i}{n^{*}\sum_{i=1}^{n} i^2-(\sum_{i=1}^{n} i)^2}$$

In the formula: Slope is the slope of the NDVI variation trend; n is the number of years in the monitoring time period. This study is divided into two time periods, 2000-2009 and 2010-2019, for nearly 20 years, and n is 10; NDVIi represents the vegetation in the i-th year index. When

Slope>0, it means that vegetation growth tends to improve, and Slope<0 means that vegetation growth tends to degenerate.

4. Results and Analysis

4.1. Time Distribution Characteristics of NDVI

The maximum value synthesis method was used to synthesize the NDVI of Yulin City from 2000 to 2019, and the obtained maximum NDVI can better reflect the best condition of vegetation growth in Yulin City. From 2000 to 2019, the annual NDVI value of Yulin City was between 0.30 and 0.55, showing an upward trend as a whole, and individual inter-annual changes were more volatile. Among them, the annual average value of NDVI showed a significant growth trend from 2000 to 2002; from 2003 to 2014, the NDVI value in the study area maintained an overall slow upward trend, with local fluctuations; The precipitation in the study area in 2015 was the minimum in recent years, and the lack of water affected the growth of vegetation; after 2015, the NDVI in the study area showed an upward trend. The overall analysis shows that the NDVI value in the study area showed a continuous upward trend from 2000 to 2019, with local fluctuations. protection, so that the vegetation coverage in Yulin City maintains an overall upward trend.

In this study, the cumulative average of NDVI from 2000 to 2018 was used as the NDVI value of the study area for 20 years. At the same time, the vegetation coverage of the study area was divided into no vegetation area (NDVI≤0.2) and extremely low vegetation area according to the changes of different vegetation indices. (0.2<NDVI≤0.3), low vegetation area (0.3<NDVI≤0.4), medium vegetation area (0.4<NDVI≤0.5), high vegetation area (0.5<NDVI≤0.6) and dense vegetation coverage area (0.6<NDVI) . The results show that the spatial distribution of vegetation index in Yulin City has obvious differences, and the overall distribution is high in the south and low in the north, which is basically consistent with the topographical distribution of Yulin City. High vegetation and dense vegetation areas are mainly distributed in the south of Yulin City, accounting for 52.1% of the study area. The terrain in this area is mostly low mountains, hills and plains. The water and heat conditions are suitable for vegetation growth. Most of the vegetation types are forest land and cultivated land; The area is distributed in the central part of the study area and the east of Yulin City. This area is located in the center of the Loess Plateau, with serious soil erosion and low vegetation coverage. 6.6%, distributed in the windy beach area of the Mu Us sandy land, the terrain is mostly denuded dunes and grasslands between the dunes, the vegetation coverage is low, the ecological environment is fragile, and it is easily affected by the natural environment and human activities.

4.2. Dynamic Variation Characteristics of NDVI in Yulin City

It can be seen from Table 1 that there are obvious differences in the variation trend of the vegetation index in Yulin City in each time period. From 2000 to 2009, the average slope of vegetation cover change in Yulin City was 0.013 1/a. In the past 10 years, the overall vegetation of Yulin City has shown an obvious upward trend. The areas with improved vegetation coverage accounted for 79.44% of the study area, and most of them were highly improved areas; 15.53% of the areas remained basically unchanged, and only 5.03% of the area was covered with vegetation. The degraded areas are mainly distributed in the western mountainous areas and the edge of the Mu Us Sandy Land; from 2009 to 2018, the average slope of the vegetation coverage change in Yulin City was 0.007 8/a, and the vegetation coverage in the study area continued to maintain an upward trend. The area with improved vegetation coverage accounts for 68.52% of the study area, 24.89% of the area is basically unchanged, and 6.59% of the area has degraded vegetation. The degraded areas are mainly distributed around Yuyang District and other urban fringes. The main reasons are The rapid expansion of cities and towns in the past ten years has resulted in a certain degree of damage to the surrounding vegetation, resulting in a decline in the vegetation index.

Comparing 2000-2009 and 2009-2018, it can be found that the growth rate of vegetation index in Yulin City has slowed down. At the end of the 20th century, the Yulin government actively responded to the national policy and implemented huge sand land control projects such as returning farmland to forests and grasslands, flood diversion and silting, construction of wind and sand prevention forests, and steep slope land management. The implementation of these projects has protected the stability of the natural surface. Therefore, from 2000 to 2009, the vegetation index of Yulin City increased significantly. With the continuous development of the city, the ecological environment around the city has been damaged to a certain extent. In addition, the results of the early sand control projects need to be maintained by the government and the people. In the next ten years, the growth rate of the vegetation index in Yulin City slowed down, but only 8.19% of the regional vegetation has been degraded, which fully reflects the contribution of the people of northern Shaanxi to the healthy development of the ecological environment of Yulin City.

Table 1. Proportion and area of different NDVI slope in Northern Shaanxi from 2000 to 2018

NDVI variance tread	Slope range	2000—2009	2009—2018
		Proportion	Proportion
Severely degraded	<-0.007 79	1.27%	1.35%
Moderate degeneration	-0.007 79~-0.000 98	3.76%	6.84%
Unchanged	-0.000 98~0.00 394	15.53%	23.86%
Moderate improvement	0.003 94~0.009 25	28.29%	32.15%
Highly improved	>0.009 25	51.15%	35.80%

5. Conclusion

The linear regression slope method can better reflect the vegetation change trend in the study area, and can comprehensively consider the results and process of vegetation change, and has better applicability. There are obvious differences in the interannual variation trend of vegetation index in Yulin City. From 2000 to 2009, the average slope of NDVI in Yulin City was 0.013 1/a, showing an obvious upward trend; from 2009 to 2018, the average slope of NDVI in Yulin City was 0.007 8/a, and the vegetation coverage continued to maintain an upward trend, but the rate of improvement Slowed down, the degraded area increased to 8.19%, mainly distributed in the periphery of Yuyang District and other urban fringes.

Acknowledgments

This work was supported by the Natural Science Basic Research Program of Shaanxi (Program No.2021JM-447) and Scientific Research Item of Shaanxi Provincial Land Engineering Built-up Group (DJNY2021-33).

References

[1] LI Jianfei, LI Xiaobing, ZHOU Yi. Spatial-temporal Variation of Growing-season Normalized Difference Vegetation Index and Impact Factors in Ulanqab City from 2000 to 2015. Arid Zone Research, 2019, 36(5): 1 238-1 249.

[2] LIU Shaohua, YAN Denghua, SHI Xiaoliang, et al. Inter-annual variability of vegetation NDVI accumulated temperature and precipitation and their correlations in China[J]. Arid Land Geography, 2014, 37(3): 480-489.

[3] YIN Tao, WANG Ruiyan1, DU Wenpeng, et al. Remote Sensing Inversion of Groundwater Level in the Yellow River Delta during Plants Thrive. Journal of Irrigation and Drainage, 2018, 37(2): 95-100.

[4] GUO Ruining, GUO Qingxia, FENG Yuhao, et al. Analysis of the Factors Affecting the Spatiotemporal Soil Moisture Distribution Based on the Temperature-vegetation Drought Index. Journal of Irrigation and Drainage, 2018, 37(4): 52-58.

[5] GAN Chunying, WANG Xizhi, LI Baosheng, et al. Changes of Vegetation Coverage During Recent 18 Years in Lianjiang River Watershed. SCIENTIA GEOGRAPHICA SINICA, 2011, 31(8): 1 019-1 024.

[6] DING Shaowen, CHEN Yiyan, TAN Lirong, et al. Vegetation Changes in the Meng Mountain Region from 2001 to 2016 Based on MODIS Data[J]. Journal of Capital Normal University (Natural Science Edition), 2018, 39(4): 81-87.

[7] ZHANG Xucai, JIN Xiaomei, ZHU Xiaoqian, et al. Spatial-temporal Characteristics of Vegetation Index and Its Impact Factors in the Golmud River Basin. GEOSCIENCE, 2019, 33(2): 461-468.