Spatiotemporal Variation of Growing Season NDVI and Its Influencing Factors in Ulanqab City, 2000-2015: Postprint

Authors: Li Jianfei

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Abstract

Based on the MODIS China 500M NDVI monthly composite product data from 2000 to 2015, combined with concurrent precipitation and temperature data for Ulanqab City, and employing methods such as trend analysis, differencing, multiple linear regression analysis, and residual analysis, a pixel-scale analysis of spatiotemporal variations and influencing factors of the Normalized Difference Vegetation Index (NDVI) during the growing season in Ulanqab City over the past 16 years was conducted. The results indicate that: From 2000 to 2015, NDVI in Ulanqab City ranged from 0.354 to 0.555, exhibiting an overall fluctuating upward trend, with significant spatial heterogeneity, and characterized by a pattern of higher values in the southeast and lower values in the northwest; The vegetation cover change patterns in Ulanqab City during 2000-2004, 2005-2009, and 2010-2015 followed a trajectory of improvement → degradation → improvement. The rate of vegetation cover improvement was slower than the rate of degradation, and recovery from vegetation degradation was sluggish; Plant growth in Ulanqab City is subject to the dual influence of precipitation and temperature. NDVI exhibited a significant positive correlation with annual mean precipitation (R=0.730, P=0.001), which passed the significance test at the 0.01 level, and a negative correlation with temperature (R=-0.351, P=0.182), with this correlation being non-significant. Precipitation, rather than temperature, represents the primary climatic factor influencing plant growth. After excluding the influence of human activities, the combined contribution of precipitation and temperature to NDVI in Ulanqab City increased progressively from 0.213 to 0.805 from northwest to southeast; Areas where human activities exerted a diminishing effect on the vegetation index accounted for 55.92% of the total study area, while areas where human activities had a positive effect comprised 44.08% of the study area.

Full Text

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Temporal and Spatial Variation of NDVI and Its Affecting Factors in Ulanqab City During the Growing Season from 2000 to 2015

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1. Study Area

Ulanqab City is located between 39°37 -43°28 N and 109°16 -114°49 E, with an elevation ranging from 931 to 2306 m. The city extends approximately 458 km from east to west and 442 km from north to south, covering a total area of 5.45×10 km². The region has a temperate continental monsoon climate, with mean annual temperatures of 1.4-5.1°C and annual precipitation of 150-450 mm. The geographical location and altitude of Ulanqab City are shown in [Figure 1: see original paper].

2. Data and Methods

2.1 Data Sources

The primary dataset consisted of MODIS 500M NDVI monthly composite products from 2000 to 2015. Topographic maps at a scale of 1:1,000,000 were obtained from the Resource and Environmental Science Data Center (http://www.resdc.cn). Land use data were classified into six categories: farmland, forest, grassland, water bodies, built-up areas, and unused land.

2.2 Methods

2.2.1 NDVI Data Processing NDVI data for the growing season (May-September) from 2000 to 2015 were extracted. The maximum value composite (MVC) method was applied to generate annual NDVI datasets. Trend analysis was performed using linear regression, and the differential method was used to detect change trajectories. Complex linear regression analysis and residual analysis were employed to quantify the relative contributions of climate factors and human activities to NDVI variation.

The overall trend of NDVI in Ulanqab City fluctuated between 0.354 and 0.555 during 2000-2015, with obvious spatial heterogeneity—higher values in the southeast and lower values in the northwest [Figure 2: see original paper]. Vegetation change exhibited a distinct pattern of improvement→degradation→improvement across the three periods: 2000-2004, 2005-2009, and 2010-2015. The degraded vegetation showed slow recovery.

The correlation analysis revealed that vegetation growth was significantly positively correlated with annual precipitation (r=0.730, P=0.001), passing the significance test at the 0.01 level, but negatively correlated with temperature (r=−0.351, P=0.182). The spatial distribution of precipitation and temperature contributions to NDVI gradually increased from 0.213 in the northwest to 0.805 in the southeast [Figure 12: see original paper].

Human activities played a dual role, with areas experiencing vegetation index reduction accounting for 55.92% of the total study area, while areas with increased vegetation index accounted for 44.08% [Figure 13: see original paper].

Abstract: In this paper, the spatiotemporal change of the Normalized Difference Vegetation Index (NDVI) and its affecting factors in Ulanqab City in recent 16 years were analyzed. The study was based on the monthly synthetic product data of MODIS China 500M NDVI from 2000 to 2015 and the precipitation and temperature data in the same period. The trend line analysis, differential method, complex linear regression analysis and residual method were used. The results showed that: The vegetation NDVI in Ulanqab City varied in a range of 0.354-0.555 during the period of 2000-2015, and the overall trend fluctuated and its spatial distribution was obvious. It was high in the southeast but low in the northwest; The vegetation types in Ulanqab City were in a trend of improvement→degeneration→improvement during the periods of 2000-2004, 2005-2009 and 2010-2015, and the degenerated vegetation was regenerated slowly; Vegetation growth in Ulanqab City was affected by both precipitation and temperature. There was a significantly positive correlation between the NDVI and the annual precipitation (r=0.730, P=0.001), which passed the significance test at 0.01 level, but a negative one between the NDVI and the temperature (r=−0.351, P=0.182), and the correlation between the two climatic factors was not significant. Without considering the influence of human activities, the contribution of precipitation and temperature to vegetation NDVI was gradually increased from 0.213 to 0.805 from the northwest to the southeast; The areas where human activities played a role in reducing vegetation index and increasing it accounted for 55.92% and 44.08% of the total study area respectively.

Keywords: NDVI; spatiotemporal variation; complex linear regression; climatic factor; human activity; Ulanqab City

Note: Figure translations are in progress. See original paper for figures.