

基于 kNDVI 的黄河流域植被覆盖时空变化及气候驱动分析 (2001—2020)

冯雪娟 田佳*

(宁夏大学林业与草业学院 银川 750021)

【目的】黄河流域是我国重要的生态屏障,也是我国生态环境相对脆弱的地区之一。研究黄河流域长时间序列植被覆盖时空变化趋势及其驱动因素对于黄河流域生态环境建设及可持续发展具有重要意义。【方法】本研究通过在 GEE 平台(Google Earth Engine)构建植被指数 kNDVI (kernel normalized difference vegetation index)来探明黄河流域 2001—2020 年间植被覆盖的时空变化趋势及其气候驱动因子分区。使用 Theil-Sen Median 趋势分析、Mann-Kendall 检验及 Hurst 指数等方法,探明了黄河流域 2001—2020 年植被覆盖的时空变化趋势及植被未来变化趋势;通过分析 kNDVI 与温度、降雨的偏相关系数与复相关系数,得到黄河流域植被覆盖气候驱动因子的空间分布格局。【结果】黄河流域植被 kNDVI 呈现出东南高、西北低的空间分布格局;2001—2020 年间植被 kNDVI 以增长率为 0.0995/5a 波动增长,75.89%的植被覆盖空间变化趋势表现为改善,22.05%表现为保持不变,2.06%表现为退化;95.41%区域的植被覆盖变化趋势表现出可持续性,其中“持续改善”的面积占比为 73.20%。黄河流域植被对气候因子的响应较强,对降水的响应强于温度;在 0.05 显著性水平下,82.60%的植被覆盖驱动因子表现为非气候因子驱动,主要分布在河南、陕西南部、山西、内蒙古西部、宁夏和甘肃东部;气候因子驱动面积占比为 17.40%,主要分布在陕北、山东、青海、甘肃西部、内蒙古东北部、四川等地。【结论】2001—2020 年间黄河流域植被整体向好,植被变化趋势以显著改善为主,非气候因素为黄河流域植被覆盖的主要驱动力。本研究结果对黄河流域生态恢复与可持续发展具有重要意义。

关键词: kNDVI (Kernel Normalized Difference Vegetation Index); 植被覆盖; 时空变化趋势; 驱动力分析; 黄河流域

Spatio-temporal Variation and Climatic Driving Factors of Vegetation Coverage in the Yellow River Basin from 2001 to 2020 Based on kNDVI

Abstract: 【Objective】 The Yellow River Basin (YRB) is a fundamental ecological barrier in China and is one of the regions where the ecological environment is relatively fragile. Studying the spatio-temporal variations in vegetation coverage in the YRB and their driving factors through a long-time-series vegetation dataset is of great significance to eco-environmental construction and sustainable development in the YRB. **【Method】** We sought to characterize the spatio-temporal variation in vegetation coverage and its climatic driving factors in the YRB from 2001 to 2020 by constructing a new kernel normalized difference vegetation index (kNDVI) dataset based on MOD13 A1 V6 data from the Google Earth Engine (GEE) platform. Using Theil-Sen median trend analysis, the Mann-Kendall test, and the Hurst exponent, we investigated the spatio-temporal variation characteristics and future development trends of the vegetation coverage. The climatic driving factors of vegetation coverage in the YRB were obtained via partial correlation analysis and complex correlation analysis of the associations between kNDVI and both temperature and precipitation. **【Result】** The spatial distribution pattern of kNDVI in the YRB showed that vegetation coverage was high in the southeast and low in the northwest. Vegetation coverage fluctuated from 2001 to 2020, with a main significant trend of increasing at a growth rate of 0.0995/5a. The areas with improved vegetation coverage accounted for 75.89%, the areas with stable vegetation coverage accounted for 22.05%, and the areas with degraded vegetation coverage accounted for 2.06%. The areas with sustainability accounted for 95.41% and the areas presenting “sustainability and improvement” accounted for 73.20% of the total. The response of vegetation to climatic factors was strong in the YRB, with a stronger response to precipitation than to temperature. At the 0.05 significance level, the main driving factors of vegetation coverage in the YRB were found to be non-climatic factors and accounted for 82.60%, which were mainly distributed in Henan, southern Shaanxi, Shanxi, western Inner Mongolia, Ningxia, and eastern Gansu. The area driven by climate factors accounted for 17.40%, mainly distributed in northern Shaanxi, Shandong, Qinghai, western Gansu, northeastern Inner Mongolia and Sichuan. **【Conclusion】** From 2001 to 2020, the vegetation coverage in the YRB was generally showed improved, and the spatial variations of the vegetation coverage was mainly improved significantly. Non-climate factors were the main driving force of the vegetation coverage in the YRB. Our findings have implications for ecosystem restoration and sustainable development in the YRB.

Keywords: kNDVI (kernel normalized difference vegetation index); vegetation coverage; spatial-temporal change; driving factors; Yellow River Basin