Spatiotemporal Evolution of NPP in Sandy Land of China's Seasonal Freezing-Thawing Typical Region

Jingfa Wang, Jilin Normal University, China
Huishi Du, Jilin Normal University, China*

ABSTRACT

Based on the data set of AVHRR GIMMS, TERRA/AQUA MODIS NDVI, and climate data from 1982 to 2018, CASA model, GIS spatial analysis, and mathematical statistics were used to study the changing law in the category of time and space, spatial distribution, and the correlativity between the NPP and meteorological factors in the sandy land of China's Seasonal Freezing-Thawing Typical Region. The results showed that the average annual NPP value of vegetation in the growing season of the sandy land from 1982 to 2018 fluctuated between 217.65-356.61 gC/m^{2}a, showing an obvious seasonality and a significant increase. The spatial distribution of NPP in the sandy land in the near 37a is significantly different. There are significant seasonal differences in vegetation responses to temperature, precipitation, wind speed, evaporation, and other meteorological factors in different regions. The increase of vegetation cover in sandy land of China's Seasonal Freezing-Thawing Typical Region is controlled by regional atmospheric circulation and human dynamics.

KEYWORDS

Driving Force, NPP, Seasonal Freezing-Thawing Typical Region, Space-Time Evolution

INTRODUCTION

In the global ecosystem, vegetation has important indication function in the conservation of soil erosion, regulation of the atmosphere, maintenance of climate, and stability of the entire ecosystem (Richards et al., 2022; Song et al., 2021). Net primary productivity (NPP) can directly represent the apparent changes of ecological environment and ecosystem production capacity, and can be reflected in the process of environmental climate change in geophysics and biogeochemistry (Becknell et al., 2021; Zhou et al., 2022). NPP is important index functions to study various terrestrial ecological processes (Chen et al., 2021). Accurate monitoring of regional NPP has important practical application value for the assessment of vegetation resource changes, exploration of vegetation production potential, and rational utilization of resources (Zhang et al., 2020). It is the important core content of research on contemporary earth material circulation science to estimate regional ecosystem vegetation NPP, quantitatively study its spatiotemporal change characteristics, and analyze its relationship with climate

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*Corresponding Author

change (Jin et al., 2020). Therefore, the measurement and evaluation of NPP on a global scale or in a specific region has attracted much attention from researchers (Wei et al., 2022). Remote sensing model estimation is an effective method to obtain NPP on a large scale, quickly and accurately (Ge et al., 2022). During the years 1965-1974, scholars from various countries established the CASA, Miami, Thornthwaite, Chikugo, and other models by combining measured data with climate and environmental factors, and conducted a large number of assessments and tests on NPP (Liu et al., 2022). Among the many regional terrestrial NPP estimation models, the CASA model is simple and practical, and is one of the most potential research methods (Zhang et al., 2021).

Freezing-thawing erosion area refers to an area characterized by strong freezing-thawing action and corresponding landform of freezing-thawing erosion (Tao et al., 2021). The sands in China's seasonal freezing-thawing typical region are located at the northeast sea-land transition zone of the Eurasian continental mid-latitude giant sand belt and the eastern edge of China's sandy desertification land, and the regional climate and human activities have regional characteristics (Gao et al., 2021). Researchers in China have conducted much work on freeze-thaw area vegetation NPP (Wang et al., 2021). However, most of the research scholars have studied specific study areas, short time series NPP, and its influencing factors, and relatively few studies have been conducted on the spatial distribution of long time series NPP and significant and potential factors affecting NPP changes in the sandy areas of the freezing-thawing erosion area of China. Therefore, in this paper, the authors chose the sand in China's seasonal freezing-thawing typical region as their research object. They used AVHRR GIMMS, TERRA/AQUA MODIS NDVI data, and the more time and space scales to calculate the sand vegetation NPP dynamic change trend between whole and parts, combined them with meteorological data such as temperature, precipitation, wind speed, and evaporation, and discussed the sand vegetation NPP dynamic evolution and drive. To clarify the change process and driving force of NPP in spatiotemporal evolution of NPP in sandy land of China's seasonal freezing-thawing typical region, the paper provides basic data for the further implementation of ecological restoration project and ecological civilization construction.

BACKGROUND OF THE RESEARCH AREA

The total sand area of the spatiotemporal evolution of NPP in sandy land of China's seasonal freezing-thawing typical region the authors studied in this paper is about 423,763.35 km^2, located at 42°30' - 50°40'N and 115°30' - 129°10'E, including Horqin, Songnen, and Hulun Buir sandy land (Figure 1). Horqin sandy land of 64 387.22 km^2 is located in 42°30' - 44°50'N, 118°30' - 124°15'E. The average temperature per year is 5.2 - 6.4°C and the annual precipitation is 343 - 500 mm. Songnen sandy land was at 43°00' - 50°40'N, 119°20' - 129°10'E and with an area of 352,559.12 km^2. The average temperature per year is 3.3°C and the average precipitation per year is 360-480 mm. Landscape was mainly fixed sand dune. Plants included *Ulmus pumila L.*, *Armeniaca sibirica (L.) Lam.*, *Stipa grandis P. Smirn.*, *Artemisia halodendron Turcz. exBess.*, and *Caragana microphylla Lam.* Hulun Buir sandy land was at 46°40' - 50°20'N, 115°30' - 122°25'E and with an area of 6,817.01 km^2. The average temperature per year is 2.5°C and the annual precipitation is 280 - 400 mm.

DATA AND METHODS

Data Source and Processing

GIMMS NDVI data using NASA global testing with the model group (GIMMS) provide GIMMS NDVI and biggest synthetic data, time series of 1982-2006, the data set is currently the longest time series of NDVI data (Ali et al., 2020). MODIS NDVI data adopt MOD13A2 data products from NASA'S EOS/MODIS NDVI data (https://lpdaac.usgs.gov), and the time series is 2001-2021 (Yan et al., 2022). Since GIMMS and MODIS have different sensors, significant differences exist in near-

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