Identification and Monitoring of Desertified Land in China from 2000 to 2015: Postprint

Authors: Hu Yunfeng, Zhang Yunzhi

Date: 2018-11-14T00:00:00+00:00

Abstract

Desertification represents an extreme manifestation of ecological degradation, referring to land degradation in arid, semi-arid, and dry sub-humid regions caused by various factors including climate variability and human activities. Rapid and accurate identification of desertified areas in China is crucial for the prevention and control of desertification. This paper conducts a comprehensive analysis of the trends, stability, and desertification sensitivity of Net Primary Productivity (NPP) in China' s terrestrial ecosystems from 2000 to 2015, and constructs a technical methodology for identifying desertified land. The main conclusions are: (1) Over the past 16 years, vegetation net primary productivity has exhibited varying degrees of declining trends in areas south of the Yinshan Mountains in Inner Mongolia, north of the Tianshan Mountains in Xinjiang, the Ali region of Tibet, and most areas south of the Yangtze River, with more than half of these regions experiencing unstable conditions in vegetation ecosystems; 56.2% of the national territory falls within desertification-sensitive zones, where the aforementioned areas are susceptible to desertification under the influence of climate, natural conditions, and human disturbances. (2) Since 2000, the area of desertification-degraded land in China is approximately 20.74$×10^{4}$ km^2, accounting for 2.16% of the total national territory. These are mainly distributed across five regions: the typical steppe and desertified steppe region in central Inner Mongolia Plateau, the mountain steppe region of the Tianshan-Altai Mountains in Xinjiang, the temperate desert and oasis region in the lower reaches of the Tarim River in Xinjiang, the Ali-Kunlun alpine desert region on the Qinghai-Tibet Plateau, and the Qinnanshan alpine steppe region in Qinghai Province. (3) The desertification process is accompanied by evolving characteristics of key surface parameters including declining productivity, reduced vegetation coverage, and continuously rising surface temperatures. The formation of desertification is significantly influenced by climate, with reduced precipitation being the primary factor driving the prominent progression of land desertification; human activities, unreasonable crop cultivation, and animal husbandry

also contribute to promoting land desertification to a certain extent.

Full Text

Preamble

DOI: 10.12118/j.issn.1000-6060.2018.06.20
Journal: Arid Land Geography (ChinaXiv Partner Journal)

Title: Identification and Monitoring of Desertification Lands in China from 2000 to 2015

Authors: HU Yun-feng[1],[2], ZHANG Yun-zhi[1],[2], HAN Yue-qi[1],[2]
[1] State Key Laboratory of Resources and Environmental Information System, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China
[2] University of Chinese Academy of Sciences, Beijing 101408, China

Abstract: Desertification represents an extreme manifestation of ecological degradation, referring to land deterioration in arid, semi-arid, and dry sub-humid regions caused by various factors including climate variability and human activities. Rapid and accurate identification of desertification lands is critical for effective prevention and control of deserts and desertification. This paper analyzes the changing trends, stability, and desertification sensitivity of terrestrial ecosystem NPP in China from 2000 to 2015, and constructs a technical method for identifying desertification lands. The main conclusions are: (1) Over the past 16 years, net primary productivity has exhibited varying declining levels in the southern Yin Mountains of Inner Mongolia, the northern Tianshan Mountains in Xinjiang, and most regions south of the Yangtze River, with vegetation ecosystems in more than half of these regions existing in an unstable state. Approximately 56.2% of the country' s land area belongs to desertification-sensitive zones that are susceptible to desertification due to climate, natural conditions, and human disturbance. (2) Since 2000, the area of desertification lands in China is approximately 207,400 km^2, accounting for 2.16% of the total land area. This area can be divided into five regions: the typical grassland and desertification steppe on the central Inner Mongolia Plateau, the Tianshan-Altay Mountains steppe area in Xinjiang, the temperate desert and oasis area in the lower reaches of the Tarim River in Xinjiang, the alpine desert area of the Ali-Kunlun Mountains on the Qinghai-Tibet Plateau, and the southern Qinghai alpine grassland area. (3) The desertification process is accompanied by evolution of key parameters including decreasing productivity, reduced vegetation cover, and rising surface temperatures. Desertification formation is influenced by climate, with decreasing rainfall being the primary factor driving the process. Additionally, human activities and unreasonable farming and animal husbandry practices have also contributed to desertification expansion.

Keywords: NPP; desertification; spatial distribution; ecological degradation

1 Introduction

1.1 Data Sources and Indicators

This study employs multiple ecological indicators including Net Primary Productivity (NPP), Normalized Difference Vegetation Index (NDVI), Leaf Area Index (LAI), and Land Surface Temperature (LST). Meteorological data comprising precipitation, wind speed, and temperature are derived from national meteorological station observations. Topographic data is obtained from Digital Elevation Model (DEM) sources. All data processing and spatial analysis are conducted using ArcGIS software.

Vegetation index data are acquired from MODIS satellite products: NDVI from MODIS 13A2 (16-day composites), NPP from MODIS 17A3 (annual composites), and LAI from MODIS MCD15A3H. These datasets provide spatial resolutions of 1 km and 500 m, respectively, covering the period 2000–2015. Meteorological station data undergo Kriging interpolation to generate continuous 1 km resolution raster surfaces matching the vegetation data extent.

A desertification index (Di) is constructed to quantify desertification sensitivity based on four key factors: precipitation, wind speed, temperature, and vegetation cover. The index is calculated as:

$$D_i = 4 \times I_i \times W_i \times T_i \times C_i$$

where D_i represents the desertification index for pixel i; I_i, W_i, T_i, and C_i correspond to normalized values of precipitation, wind speed ($\$ 6m \cdot s\hat{}\{-1\}\$$), temperature, and vegetation cover for pixel i, respectively.

Desertification sensitivity is classified using the Coefficient of Variation (CV) of NPP over the 16-year period. The classification criteria are: stable ($CV \leq 0.05$), relatively stable ($0.05 < CV \leq 0.1$), relatively unstable ($0.1 < CV \leq 0.15$), and unstable ($CV > 0.15$). This classification system enables spatial identification of regions with varying degrees of ecological stability and desertification risk.

Table 1 presents the specific classification criteria for desertification sensitivity based on NPP, NDVI, LAI, and LST indicators, integrating climate and vegetation parameters to establish threshold values for different desertification severity levels.

Table 1 Indicators and classification criteria for desertification sensitivity assessment (2000–2015)

Indicator	Low Sensitivity	Moderate Sensitivity	High Sensitivity	Very High Sensitivity
NPP ($gC/m^2/yr$)	>1000	500–1000	200–500	<200
NDVI	>0.4	0.2–0.4	0.1–0.2	<0.1
LAI	>3.0	1.5–3.0	0.5–1.5	<0.5
LST (°C)	<25	25–30	30–35	>35

The integrated assessment combines these indicators to identify desertification lands and analyze their spatial distribution patterns across China from 2000 to 2015. The methodology provides a robust framework for monitoring ecological degradation and supporting desertification control efforts.

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