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NDVI Change Trend and Impact Factors Dataset in Inner Mongolia (2000–2015)

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Abstract: Based on monthly 1 km SPOT/VEGETATION NDVI data from 2000 to 2015, a dataset of annual NDVI data was generated using the maximum value synthesis method. Then statistical yearbook data, trend analyses, and a geographical detector model were used to calculate the trend of change in the NDVI and to assess the impact factors for Inner Mongolia. The dataset is categorized into GIS 1 km raster data; information on the degree of change in the NDVI; data on natural phenomena such as precipitation, average temperature, slope aspect, and so on; and human-related components such as changes in rural populations, labor force, grain output, and per capita net income of farmers and herdsmen, among others. Some data are also provided in table format, including the area and proportion of change in vegetation and the main impact factors.

Keywords: geographical detector; vegetation NDVI; Inner Mongolia; human factors; natural factors

Dataset Available Statement:

The dataset supporting this paper was published at: Chen, K., Chao, L. M. Dataset of NDVI change trends and impact factors in Inner Mongolia (2000–2015) [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2020. DOI: 10.3974/geodb.2020.05.07.V1.

1 Introduction

Vegetation is a vital part of terrestrial ecosystems that serves as a hub of material circulation, energy flow, and information transmission[1–2]. Changes in vegetation coverage can indicate fluctuations or changes in whole ecosystems to a certain degree[3]. Particularly in arid and semi-arid areas, changes in vegetation coverage are an important indicator for monitoring and evaluating changes in ecology[4]. Therefore, it is of great significance to quantitatively analyze changes in regional vegetation coverage and explore the driving factors.

Inner Mongolia is a vast territory with a high diversity of ecosystems, although the main landform is the Mongolian Plateau[5]. Due to this plateau, Inner Mongolia is an important ecological barrier in northern China. The region has an arid and semi-arid climate, and has been reported to be particularly sensitive to global climate change[4].

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Regarding human industry, the counties in the Inner Mongolia autonomous region are mainly divided into pastoral, agricultural, semi pastoral, semi agricultural and urban areas. Pasture area is dominated by grazing, where natural grassland is the main vegetation type. Non-animal husbandry is the main vegetation type in other counties, and farmland is the main land use type[6].

The dataset is developed based on the SPOT/VEGETATION NDVI database. Then we calculated the trend of change in the NDVI for 2000 to 2015 and assessed the natural and human factors using statistical data, trend analyses, and a geographical detector model[7]. The dataset provides a useful reference on the vegetation in this region, how it has changed, and the main driving factors, and may serve as a guide for urban and rural developmental decisions.

2 Metadata of the Dataset

The metadata summary of the "Dataset of NDVI change trends and impact factors in Inner Mongolia (2000–2015)" is shown in Table 1.

Table 1 Metadata summary of the dataset

Items	Description
Dataset full name	Dataset of NDVI change trends and impact factors in Inner Mongolia (2000–2015)
Dataset short name	NDVIChange.InnerMongolia_2000-2015
Authors	Chen, K., College of Ecology and Environment, Inner Mongolia University, im_chk@163.com Chao, L. M., College of Ecology and Environment, Inner Mongolia University, colmvn@aliyun.com
Geographical region	Inner Mongolia Year 2000–2015
Data format	.tif, .xlsx, .shp Data size 51.7 MB (after compression)
Data files	Spatial data include (1) annual variation trend of NDVI in Inner Mongolia from 2000 to 2015, 1 km raster data; (2) Categorize 1 km raster data based on the degree of change annual variation trend of NDVI from 2000 to 2015; (3) Natural factor data, including 2000–2015 precipitation, average temperature change trend, slope aspect, slope classification and vegetation type 1 km grid data; (4) Human-factor GIS data based on county units, including six attribute data from 2000 to 2015, including the trend of change in rural population, the trend of change in rural household number, the trend of change in rural labor force, the trend of change in grain output, the trend of change in per capita net income of farmers and herdsmen, and the trend of change in livestock quantity. Tabular data include the (1) area and proportion of vegetation change grade divided based on vegetation NDVI change. (2) Main impact factors and *q* values of vegetation NDVI change in Pastoral banner county and non-pastoral banner county in Inner Mongolia.
Foundations	Ministry of Science and Technology of P. R. China (2016YFC050604–4); National Natural Science Foundation of China (31060117)
Data publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	***Data*** from the Global Change Research Data Publishing & Repository includes metadata, datasets (in the *Digital Journal of Global Change Data Repository*), and publications (in the *Journal of Global Change Data & Discovery*). ***Data*** sharing policy includes: (1) ***Data*** are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use ***Data*** subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute ***Data*** subject to written permission from the GCdataPR Editorial Office and the issuance of a ***Data*** redistribution license; and (4) If ***Data*** are used to compile new datasets, the 'ten per cent principal' should be followed such that ***Data*** records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[9]
Communication and searchable system	DOI, DCI, CSCD, WDS/ISC, GEOSS, China GEOSS, Crossref

3 Data Development

This study used time series SPOT/VEGETATION NDVI data from 2000–2015[10] with the maximum synthesis method to generate an annual NDVI. The natural factors considered were climate, elevation, and vegetation. The climate data included annual precipitation and annual average temperature with 1 km resolution calculated by interpolation. Elevation with 1 km resolution was generated by resampling based on the latest SRTM V4.1 data. Vegetation types were derived from 1:1 million vegetation maps of China with a resolution of 1 km. Slope and aspect were calculated from DEM data with a resolution of 1 km[11]. Data on human factors were taken from the "Inner Mongolia Statistical Yearbook"[12]. The components included data on rural population, rural labor force, number of rural households, grain production, per capita income of farmers and herdsmen, and number of livestock (in 'sheep units', where a camel, horse, and cow are equivalent to five sheep each, and a goat is the same as one sheep).

3.1 Algorithm

The trend line analysis method was used to analyze the trend of change in the NDVI as well as climate and human factors for the study period[6]. In other words, taking time as an independent variable, the NDVI, annual average temperature, annual precipitation, and six individuals were analyzed by univariate linear regression. The correlation coefficient (R) between NDVI sequence and time (Year) was used to judge the degree and nature of change in vegetation cover, and the magnitude of the coefficient was used to judge the significance[6]. The critical value of significance was obtained from the critical value table of correlation coefficient test (when the number of samples was 16, the critical value of significance level was 0.468 and 0.590 at 0.01 and 0.05). Vegetation change was divided into five categories, according to the trend slope and critical value of NDVI: extremely significant degradation, significant degradation, no significant change, significant improvement, and extremely significant improvement.

The influences of natural and human factors on the NDVI were analyzed using the geographical detector model[7].

4 Data Results and Verification

4.1 Data Composition

The dataset includes 11 spatial data files (Table 2) and one statistical table data (including the area and proportion data of NDVI of different grades in Inner Mongolia; the main impact factors and q value of NDVI changes in pastoral and non pastoral counties of Inner Mongolia). Table 2 explains the data and describes the file or field names corresponding to the data.

4.2 Data Results

Because the geographical detector model employs an algorithm for discrete data, continuous variables (all data except vegetation type and slope aspect) were discretized using the natural breakpoint method[13]. The slope was divided into 9 categories and the other factors were divided into 10 categories (Figure 1).

Table 2 Natural and human factors affecting variation in NDVI in Inner Mongolia (2000–2015)

Category	Factors	Details	File or field
Natural factors	Annual precipitation	Variation in precipitation from 2000 to 2015	IM_pre00_15slope.tif
	Annual mean temperature	Average change in temperature from 2000 to 2015	IM_tem00_15slope.tif
	Slope	Calculated from DEM data with a resolution of 1 km	IM_slope.tif
	Aspect	Calculated from DEM data with a resolution of 1 km	IM_aspect.tif
	Vegetation type	In 1995, a 1:1 million vegetation map of China was digitally generated with a resolution of 1 km	IM_vegatation_type.tif
Human factors	Change in rural population	Rate of change in the rural population from 2000 to 2015	Rp_slope
	Change in number of rural households	Rate of change in number of rural households from 2000 to 2015	house_slope
	Change in rural labor force	Rate of change in rural labor force from 2000 to 2015	labor_slope
	Change in grain yield	Rate of change in grain output from 2000 to 2015	grain_slope
	Change in per capita net income of farmers and herdsmen	Rate of change in per capita net income of farmers and herdsmen from 2000 to 2015	Rgdp_slope
	Change in number of live-stock	Rate of change in livestock number from 2000 to 2015	sheep_slope

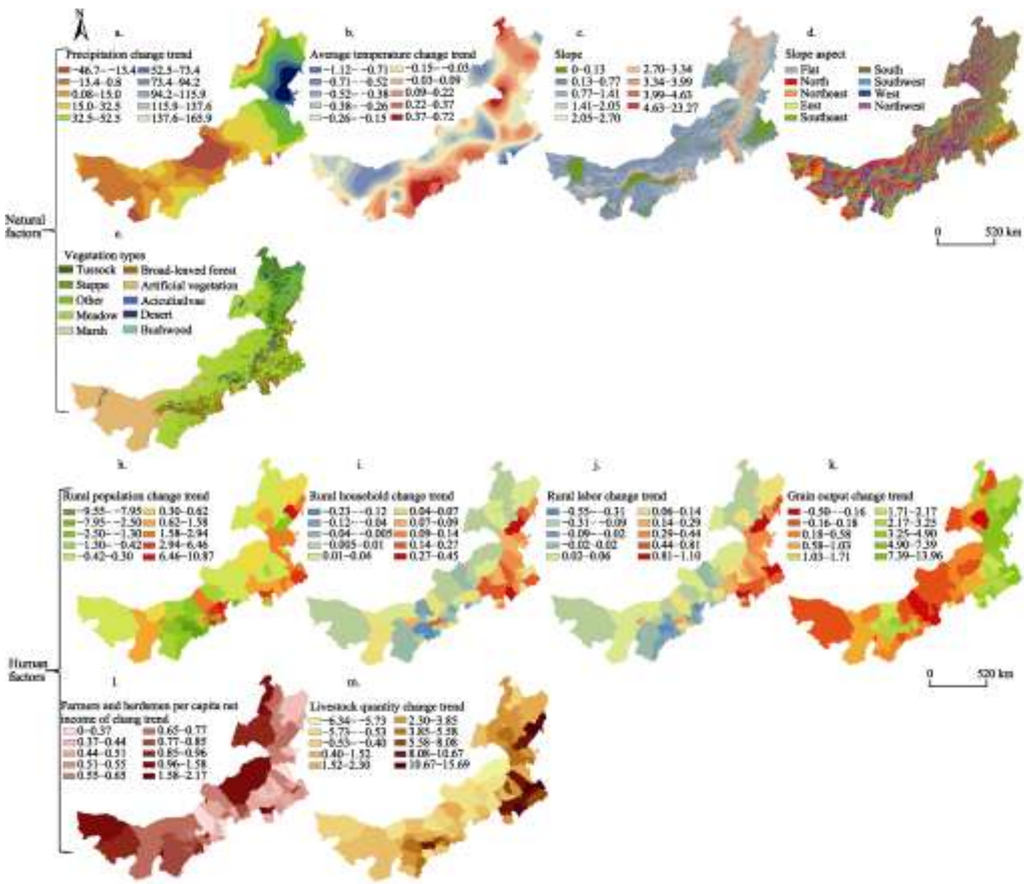

Figure 1 Map of natural and human factors affecting the NDVI for Inner Mongolia during 2000–2015

During the 16 years from 2000 to 2015, the NDVI showed an overall increasing trend. In general, it tended to decrease in the west and increase in the east and south; in other areas, it changed very little (Figure 2). Overall, an area of about 249,842.65 km^2 showed improved vegetation coverage, accounting for 21.88% of the total area of Inner Mongolia; about 64.38%, 10.88%, 1.88%, and 1.00% of the area experienced no change, a significant improvement, significant degradation, and extremely significant degradation, respectively (Table 3). These results indicate that the area of vegetation improvement was significantly greater than that of vegetation degradation. Furthermore, degraded areas were mainly distributed in the northwestern region around individual towns. NDVI varying grade is shown in Table 3. The vegetation of animal husbandry banner (county) was improved very significant, accounting for 9.65% of the total area (significant improvement: 7.24%; no change: 79.34%; significant degradation: 2.56%; very significant degradation 1.20%). The proportion of vegetation degradation area in animal husbandry banner (county) exceeds that of the whole study area, which indicates that vegetation degradation is more serious (and vegetation improvement is lower) in pastoral counties than in other areas. The vegetation of non-pastoral counties was improved very significant, accounting for 47.54% of the total area (significant improvement: 18.52%, no change: 33.00%; significant degradation: 0.35%; very significant degradation: 0.57%). Improved areas were mainly distributed in non-pastoral counties.

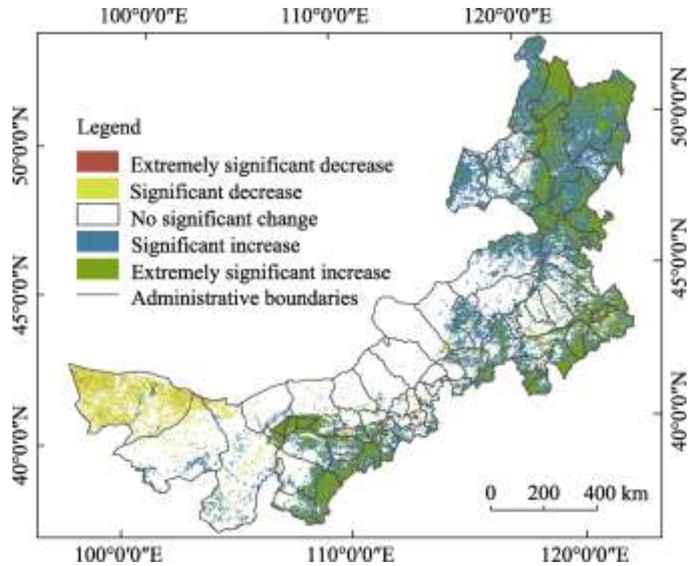

Figure 2 Spatial distribution of vegetation change in Inner Mongolia from 2000 to 2015 based on the interannual variation trend of NDVI and its significance

The factor detection of geographic detector model was used to assess the influences of natural and human factors on the NDVI, expressed using q values. The core rationale of the factor detection module is that geographic phenomenon always exists in a certain place in space and is affected by environmental factors. If certain environmental factors change with geographic phenomenon in a remarkably consistent spatial pattern, then it indicates these environment factors have great effect on the occurrence and development of geographic phenomenon[7]. Across the whole study area, the order of the degree of influence on NDVI was as follows: annual precipitation > soil type > vegetation type > grain yield > number of livestock > per capita net income of farmers and herdsmen > number of rural households > rural population > landform type > rural labor force > annual average temperature > slope > slope aspect. The first three factors are natural factors and the following two are human factors, which suggests that the influence of natural factors is greater than that of human factors. Similarly, for non-pastoral counties, the order was annual precipitation > soil type > vegetation type > grain yield > per capita net income of farmers and herdsmen > number of livestock > number of rural households > landform type > rural population > rural labor force > annual average temperature > slope > slope (Figure 3), again showing that natural factors had a greater impact. In contrast, the order for non-pastoral counties was grain output > rural labor force > annual average temperature > soil type > annual precipitation > number of rural households > per capita net income of farmers and herdsmen > number of livestock > total rural population > landform type > slope > vegetation type > slope aspect (Figure 3). These results indicate that human factors were dominant in such areas.

Table 3 Area and proportion of NDVI varying grades

Region	Classification	Very significant degradation	Significant degradation	No change	Significant improvement	Very significant improvement	Total
All counties	Area (km^2)	11,458.14	21,105.13	734,992.38	124,233.05	249,842.65	1,141,631.35
	Percentage (%)	1.00%	1.84%	64.38%	10.88%	21.88%	100%
Pastoral counties	Area (km^2)	9,335.95	19,785.55	613,648.39	56,000.29	74,631.31	773,401.50
	Percentage (%)	1.20%	2.56%	79.34%	7.24%	9.65%	100%
Non-pastoral counties	Area (km^2)	2,118.41	1,312.53	121,529.47	68,199.76	175,069.49	368,032.66
	Percentage (%)	0.57%	0.35%	33.00%	18.52%	47.54%	100%

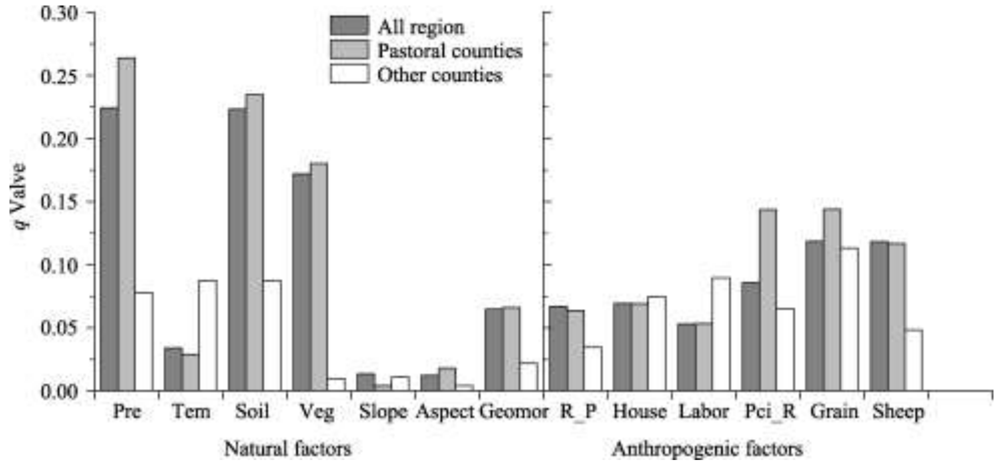

Figure 3 *q* values of seven natural factors and six human factors leading to variation in the NDVI in Inner Mongolia（Note：In natural factors, Pre, Tem, Soil, Veg, Slope, Aspect and Geomor respectively refer to annual precipitation, annual average temperature, soil type, vegetation type, slope, aspect and geomorphic type; In anthropogenic factors, R_P, House, Labor, Pci_R, Grain and Sheep respectively refer to rural population, rural household number, rural labor, per capita net income of farmers and herdsmen, grain output and livestock number）

4.3 Data Validation

The precision of VEGETATION coverage represented by NDVI lies in the spatial resolution of the source data used. In this paper, the SPOT/VEGETATION NDVI data with a resolution of 1 km is consistent with the research results of the former[14].

Geographic detector method is useful for detecting spatial differentiation and revealing the driving forces behind it. It is widely used in analyzing the evolution of geographical element pattern and regional spatial differentiation[7]. However, it should be pointed out that, as the maximum number of rows of data in the research area exceeds the upper limit of the operation of the geographic detector model, the use of the Create Random Points function of ArcGIS software to randomly extract appropriate samples in proportion for factor detection may have a certain impact on the final research results.

5 Discussion

It is of great significance to understand not only changes in regional vegetation coverage but also their driving factors over time. We used linear trend analyses and a geographical detector method to explore the impact of natural and human factors on changes in the NDVI from 2000 to 2015. Our results reveal obvious changes with an overall increasing trend in vegetation coverage. Regionally, vegetation tended to decrease in the west and increase in the east and south, with other areas showing little change. Across the entire region, about 32.76% of the area showed improvement, whereas only 2.88% showed degradation. The NDVI was affected more by natural factors than by human factors, with precipitation and soil type having the main effects. However, in non-pastoral counties, human factors had a greater impact, with grain yield being the main effect. Our dataset provides a useful reference on the vegetation in this region, how it has changed, and the main driving factors, and should help guide urban and rural developmental decisions.

Author Contributions

Chao, L. M. designed the dataset and Chen, K. collected and processed the data, and wrote the paper.

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