

The study for the Spatial Distribution Pattern of NDVI in the Western of Jilin Province

Shu-jie YANG^{1,a}, Xiao-dong LI¹, Shou-gang YAN^{1,b*}

¹School of Geography Science, Baicheng Normal University

NO. 57, Zhongxing West Road, Baicheng, China, 137000

^ayanshougang@126.com, ^{b*}corresponding author, yanshougang11@163.com

Abstract: Using methods of spatial autocorrelation analysis and trend analysis, the paper studies the spatial distribution pattern of NDVI based on the GIMMS NDVI dataset (1998-2008), in Western Jilin. The maximum value for 15d is got through the method of MAX processing. Results show that: the NDVI in growing season shows a rising trend in western Jilin in 1998-2008. In the study area, the NDVI in Western Jilin shows positive spatial autocorrelation in the whole region, but the partial NDVI is apt to scattered distribution, which means the vegetation cover of Western Jilin is generally fragmental.

1. Introduction

Because that the NDVI is sensitive to green vegetation. It's often used to study the situation of regional and global vegetation, and it's an ideal index for the study of global changes in vegetation index. Vegetation is helpful to virtuous cycle of biogeochemistry as well as water and soil conservation [1-3]. The study of sequence vegetation index for long time based on statistical methods can accurately reflect the growth change and the temporal and spatial distribution of vegetation index, and then further reveal the significance of vegetation index itself and the associated geo-statistical parameters [4-6].

The geographical location of western Jilin is of great significance, being in the center of Northeast Plain, next to Hulun Buir Grassland in the west, Horqin Sandy Land in the south and the Greater Xing'an Mountains in the north. With the increase climate changes in recent years, its desertification and ecological environment become worse. Research on the vegetation distribution characteristics of western Jilin can help to know the ecological conditions of regional vegetation and provide a scientific basis for vegetation protection and agriculture and animal husbandry.

Based on GIMMS NDVI data, this paper studies the growth trend of normalized vegetation index from 1998 to 2008 (in the past 11a) and analyzes the spatial distribution pattern of the vegetation, in western Jilin.

2. Materials and Methods

The remote sensing data used in the paper are from the synthetic maximum per 15d (MVC) of SPOT-NDVI data set from 1998 to 2008 produced by the National Natural Science Foundation of "Western China Environmental and Ecological Science Data Center". The data set uses the maximum synthesis method to eliminate maximally the influence of other factors like clouds, reduce vegetation index changes due to calibration, improve the correction of short-term atmospheric aerosols, suspended particles of volcanic eruptions and solar zenith angle, etc. It's more suitable for a



province-widely study of long-term vegetation trends. Many domestic scholars have used this data set for research on vegetation and ecological environment and achieved relatively good results [7-9].

The analysis of the growth conditions and spatial distribution pattern of western Jilin vegetation index is based on statistical methods. Acquisition and processing of surface vegetation index maximum is automatically done through the remote sensing software ERDAS8.0 and Modeler programming. The analysis of vegetation indices trend adopts the mathematical and statistical methods of Pearson correlation deficient analysis, specifically implemented under remote sensing software ERDAS8.0 and calculated by Modeler programming operation. The Spatial pattern of vegetation index is statistically analyzed through points for the number of columns for geo-statistical analysis which are extracted by GIS software Surfer7.0, and then input into the Geo-statistical software GS +7.0 as initial data.

3. Results and analysis

3.1 The time-series change analysis of the vegetation index in western Jilin

3.1.1 Change analysis of the vegetation index in the growing season

First, the paper extract the vegetation indices of western Jilin in growing seasons (May to September) from 1998 to 2008, and then average the indices of each month to obtain the monthly time-series of western Jilin vegetation index in the growing season for 11 years (Table 1). As can be seen from Table 1, the average monthly vegetation index changed significantly. The vegetation index was the smallest before May, being 0.1376. Then it increased rapidly, especially from May to July. The rapid increase began to ease after July. The vegetation index reached the annual maximum in August, being 0.3136. Compared with that of August, the vegetation index began to decrease because varieties of flora withered after September.

Table 1 Monthly vegetation index of western Jilin in the growing season, 1998-2008

	May	June	July	August	September
NDVI	0.1367	0.2023	0.2978	0.3136	0.2697

3.1.2 Inter-annual change analysis of the vegetation index of western Jilin

First, the paper extract the vegetation indices of western Jilin in the growing seasons (May to September) from 1998 to 2008, and then calculate the change slope numerical of NDVI in the growing season of the past 11a to obtain the monthly incremental changes of western Jilin vegetation index in the growing seasons (Table 2) from 1998 to 2009. As can be seen from Table 2:

Table 2: monthly incremental changes of western Jilin vegetation index in the growing seasons, 1998-2009

year	NDVI					NDVI annual average
	May	June	July	August	September	
1998	0.184	0.280	0.320	0.312	0.300	0.279
1999	0.152	0.172	0.268	0.276	0.232	0.220
2000	0.136	0.196	0.252	0.276	0.192	0.210
2001	0.112	0.148	0.228	0.240	0.212	0.188
2002	0.132	0.152	0.360	0.296	0.188	0.226
2003	0.108	0.144	0.316	0.316	0.344	0.246
2004	0.152	0.160	0.260	0.228	0.240	0.208
2005	0.120	0.168	0.432	0.228	0.356	0.261
2006	0.124	0.168	0.224	0.352	0.244	0.222
2007	0.124	0.180	0.312	0.340	0.280	0.247
2008	0.124	0.288	0.288	0.300	0.310	0.260
K_{nv}	-0.00370	1.13823	0.02552	-0.10860	0.11775	0.36554

Note: K_{nv} is the change slope numerical of vegetation index in the past 11a.

In a word, the vegetation index of western Jilin showed a clear upward trend, and the vegetation of the study area improved significantly. The monthly vegetation index of the growing season showed different changing trends in different time periods.

3.2 The spatial distribution pattern analysis of vegetation index of western Jilin

3.2.1 Spatial trend analysis of vegetation index in study area from 1998 to 2008

The paper extract the annual vegetation index (1998-2008) of western Jilin, and calculate the change of the slope over the years to obtain the spatial distribution pattern of annual vegetation index changing trend of western Jilin (Figure 1) in the past 11a.

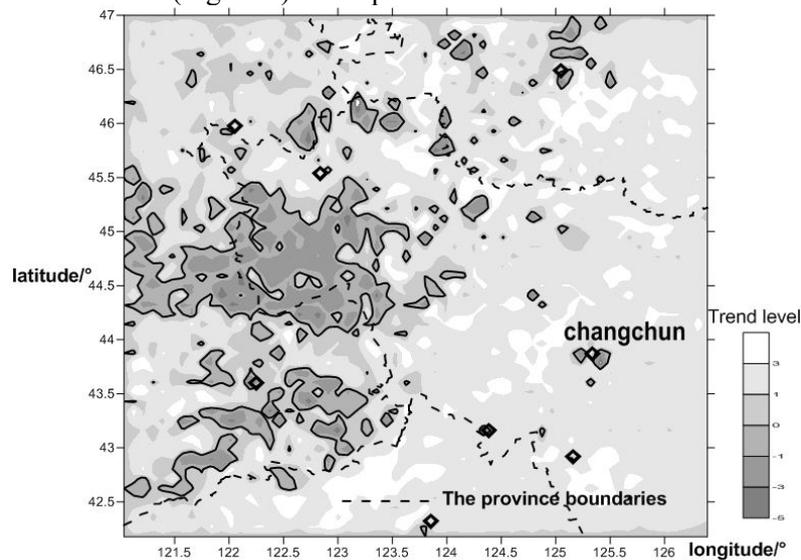
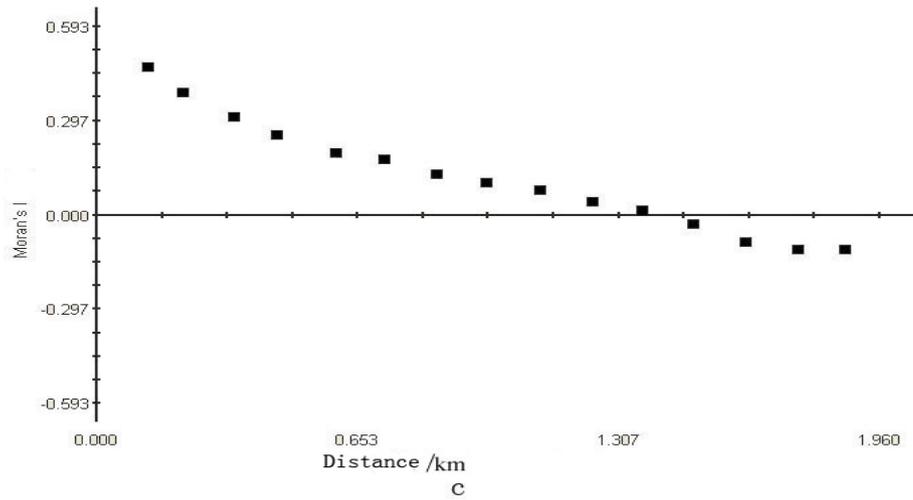
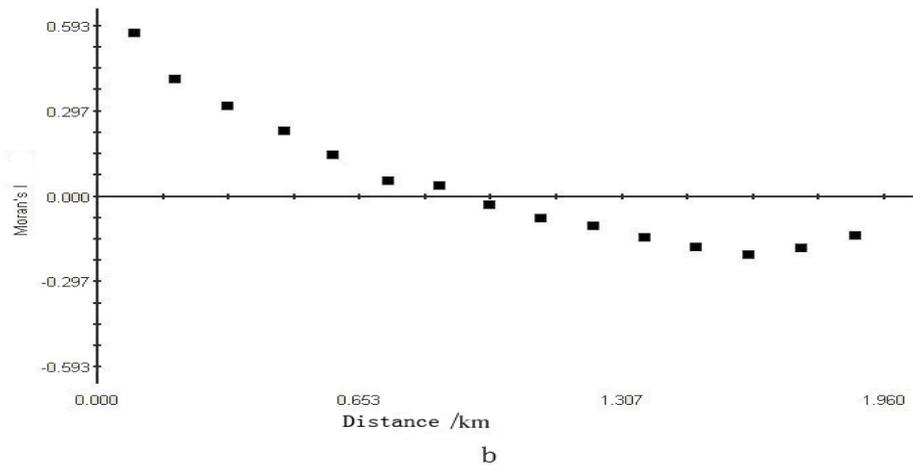
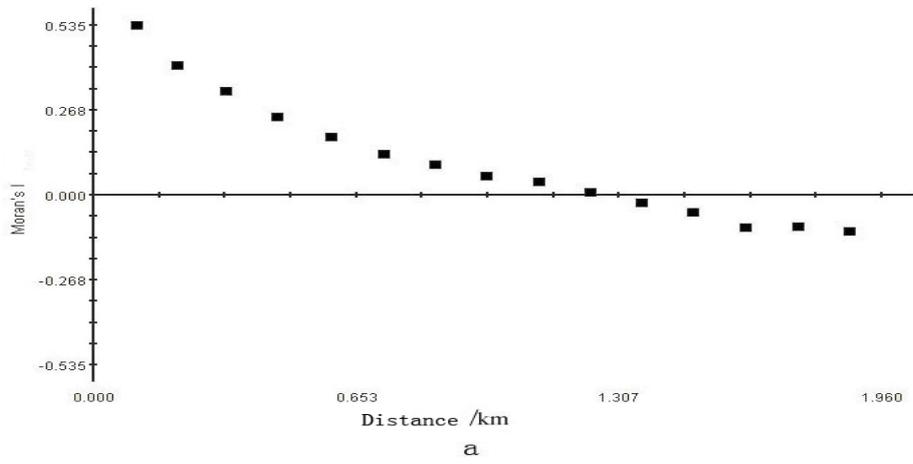


Figure 1 Spatial pattern of vegetation index changing trend of western Jilin in 1998-2008

As can be seen from Figure 1: the region with vegetation growth trend (K_{nv}) less than or equal to zero lies in the farming and pastoral eco-tone of western Jilin, which mainly centers on Horqin sandy land. There are also relatively large and centralized such regions on the eastern edge of the Inner Mongolia grasslands and in the salinity distribution of western Jilin. In general, vegetation decline zone lies in the salinity area of eco-tone and the sandy area of western Jilin.

3.2.2 Spatial pattern of vegetation in the study area, 1998-2008

We carry out the spatial autocorrelation analysis on the spatial pattern of NDVI of western Jilin by the support of GS+7.0(geo-science statistical analysis software) and get the following results shown in Figure 2:



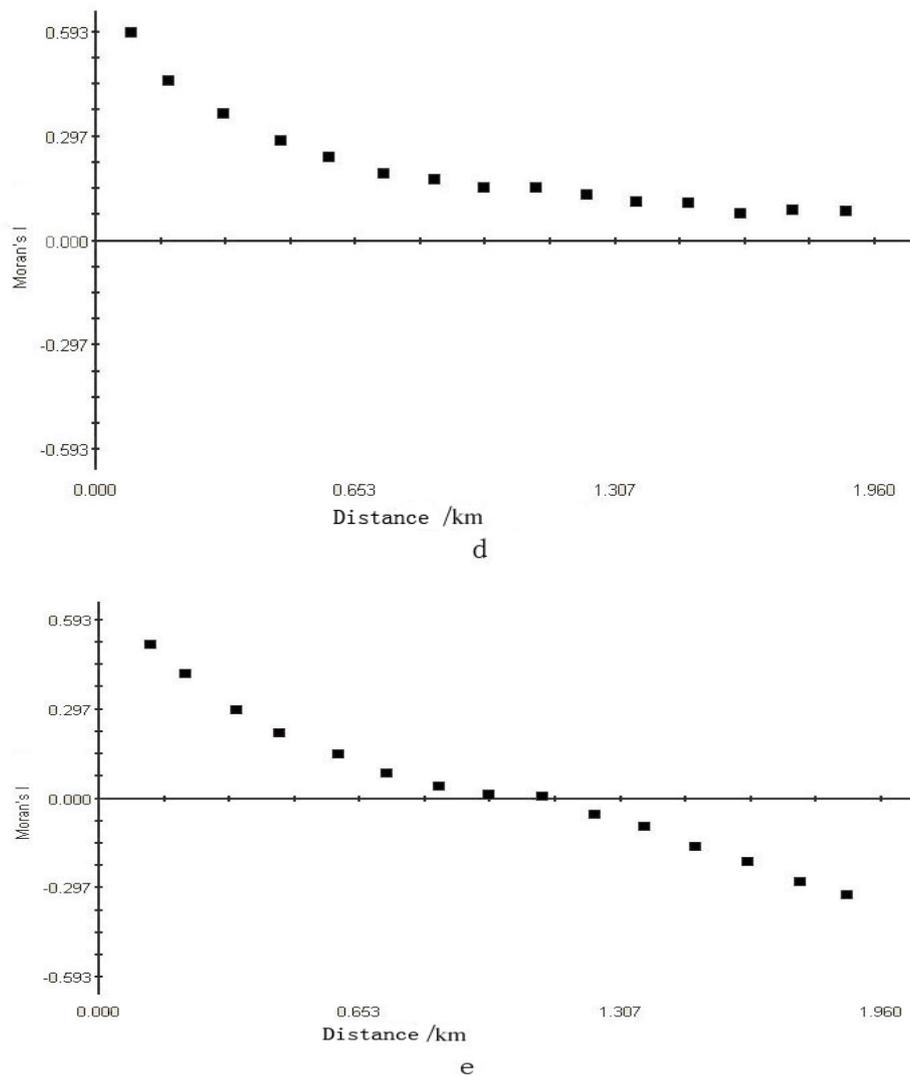


Figure 2 Moran's I coefficient analysis. A. overall; b. south-north direction; c. northeast-southwest direction; d. east-west direction; e. northwest-southeast direction.

The overall Moran's I coefficient of vegetation index of western Jilin shows that the vegetation index of western Jilin is 0.1094 in the global scope of spatial autocorrelation, and that the spatial pattern of western Jilin vegetation is dominant. The relatively small correlation coefficient means that there are differences among the representative units and their distributions are non-centralized; the weak trend for similar vegetation indices to gather together means that western Jilin vegetation has poor integrity in spatial distribution. On the whole, the vegetation index of western Jilin can be divided into several independent vegetation type units.

Table 3: Moran's I coefficient values of vegetation index of western Jilin

index	overall	South-north direction (0°)	Northeast-southwest direction (45°)	East-west direction (90°)	Northwest-southeast direction (135°)
NDVI	0.1094	0.0478	0.1216	0.2139	0.0426

Note: 0° , 45° , 90° , 135° in Table 3 stands respectively for south-north direction, northeast-southwest direction, east-west direction and northwest-southeast direction.

The Moran's I coefficients of vegetation index of western Jilin in four different directions [Figure 2 (a, b, c, d, and e)] show that the vegetation index values of western Jilin have obvious anisotropy in

different directions. The vegetation extending along northwest-southeast direction shows the minimum spatial correlation value (0.0426), which indicates relatively broken vegetation and bigger changes of vegetation types in this direction. In fact, the study area is next to Nenjiang River, belonging to the agricultural irrigation area of Nejiang-to-Baicheng Project. The Saline distribution area is in the southeast part, one of China's three major saline distribution areas. The difference in natural conditions is the important factors of broken vegetation in this direction.

4. Conclusion and Discussion

Based on GIMMS NDVI data, the following basic conclusions can be drawn after the quantitative analysis of the growth conditions and distribution of vegetation in western Jilin, using space statistical methods (spatial autocorrelation analysis, trend analysis), draw the following basic conclusions:

In general, the average monthly vegetation index of western Jilin in growing seasons shows a clear upward trend from 1998 to 2008. The growth trend of vegetation in the east of the farming and pastoral eco-tone region shows an upward trend in the past 11a. The vegetation in the study area improved greatly. Changes and growth of monthly vegetation index in growing season indicate that the growing season advances slowly as the climate warms. The vegetation in July and August are the best state, being 0.2978 and 0.3136 respectively. It can not be ignored that there are large and centralized areas of degraded vegetation in the saline-alkali soil and sandy land of western Jilin.

We know by trend analysis that vegetation decline zone (the areas in which vegetation growth trend K_{nv} is less than or equal to zero) mainly lies in the saline and sandy areas, parts of the farming eco-tone of western Jilin. Global Moran's I coefficient analysis shows that the vegetation index of western Jilin showed positive spatial autocorrelation in the global scope, but the spatial autocorrelation value is relatively small (0.1094). This indicates that the integrity of vegetation spatial distribution in the study area is poor, that similar vegetation index values tend weakly to gather together, and that partial vegetation distribution presents patchy fragments.

The spatial distribution pattern of the correlation between temperature and vegetation is consistent with that of salinity whose level is progressively decreasing from north to south. So the vegetation in western Jilin has greater degree of positive correlation in east-west direction and northeast-southwest direction, while it has a negative correlation in south-north direction and northwest-southeast direction.

In recent years, the climate in the Northeast has been changing steadily. Judging from the existing research, the impact of changes in temperature and the minimum temperature of the study area on vegetation is generally greater than the other factors such as precipitation. Temperature rise caused the growing season of vegetation to move up and become longer, which is the main reason why the overall vegetation in the study area shows an increasing trend. In the context of the overall increase of vegetation, the increasing and decreasing coverage of vegetation and its proportion vary with different types of vegetation. Arable land was significantly affected by human activities. The improved farming conditions greatly increased the area of arable land, which resulted in a significant increase of pixel vegetation index of the vegetation in the study area. And for other types of vegetation such as woodland and grassland, the ecological protection and environmental construction such as afforestation and grassland fencing have also contributed to the increase of its vegetation.

At the same time, one phenomenon can not be ignored. With the expansion of agricultural land area this year, partial vegetation degradation occurred in the study area of the farming-pastoral belt, especially herbaceous vegetation and woodland. Human factor is the main cause of the degradation. Human activity is a double-edged sword with two sides.

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