The Impact on Vegetation Dynamic of Human Activities in the Southwest China Karst

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***Abstract*—Recent trend analyses have indicated the spatial variations of vegetation dynamic in South China Karst region, such as growth in west and southwest, degradation in northwest and southeast. Whether the factories lead to vegetation degradation would be identical to the factories lead to growth was investigated in this study. The result shows that(1)about 11.5% of the total study areas have experienced a significantly decrease in the annual NDVI, and 7.8% was significant increase. The proportion of vegetation degradation was higher in spring and summer than in autumn and winter, vegetation growth were opposite. (2)The relation between NDVI and climate variation was weaker in the region scale. (3)The impact of human activities on vegetation dynamic was bidirectional. The negative influence was bigger than positive.**

Keywords—vegetation dynamic; NDVI; human activities; land cover; south China karst

I. Introduction

Southwest China Karst is one of the largest continuous Karst zone in the world**[1]**, which is an open natural environment that have three-dimensional and dual structure**[2]**. In the Karst area, due to the large contradiction between population and land, irrational land use have resulted the serious degradation**[3]**. It is difficult to restore forest and soil ecosystem because of the unique hydrological and geological conditions. Therefore, it is important to monitor forest change and to identify its causes.

This research used MODIS NDVI data, climate data, land cover data from 2000 to 2015 to examine vegetation dynamics in karst area of GuiZhou and to identify factor of different vegetation dynamic, especially focus on decrease. The result will provide a better understand for the really relationship between climate and vegetation change.

II. Materials and Methods

A. Study Area

Guizhou province is located in the southwest of China and borders on Yunnan, Sichuan, Hunan, Guangxi and Chongqing. It covers 176,000km^{2}of which 72% is karstic. The altitude of Guizhou is mostly between 1000-2000m, and the highest point is located in Jiucaiping of western area that is 2990m. Guizhou is mostly the subtropical humid monsoon zone, with an annual average temperature of 14-16 ℃ and an annual average precipitation of 1000-1300mm[4].

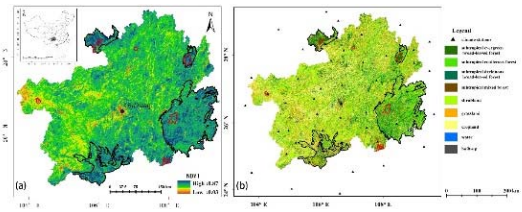

FIGURE I. (A)THE LOCATION OF THE STUDY AREA AND NDVI DERIVED FROM MODIS, COUNTIES OUTLINED WITH BLACK ARE THE AREAS WITHOUT KARST AND WITH RED ARE THE NATIONAL NATURAL RESERVE.(B)THE SPATIAL DISTRIBUTION OF LAND COVER AND CLIMATE STATIONS IN GUIZHOU PROVINCE, THE LEGEND SHOWS THE TYPES OF LAND COVER.

B. Materials

1) MODIS NDVI Time Series Data: The MODIS 16days normal different vegetation index (NDVI) produce (MYD13Q1 at a spatial resolution 250m) was collected from the Land Resources Distributed Active Archive Center (LPDAAC)(https://e4ftl01.cr.usgs.gov/)during 2000 to 2015.In this study, 16days NDVI is used to derive the monthly NDVI though maximum value composition, and monthly NDVI is used to calculate annual average NDVI(Fig. Ⅰ a).

2) Land use data: Land use change data during 2000 to 2015 was collected from the National Ecosystem Survey and Assessment of China–Guizhou province (2000-2010)[5]and Resources and Environmental Science Data Center(RESDC) of the Chinese Academy of Sciences(CAS)(http://www. resdc.cn/). (Fig. Ⅰ b).

3) Climate data: Daily temperature, precipitation and sunshine duration during 2000 to 2015 data were obtained from China Meteorological Administration (http://data.cma.cn/site/index.html). (Fig. Ⅰ b).We averaged the meteorological data to monthly and yearly values, and cumulative monthly climate values as seasonal values(March, April and May are spring, June, July and August are summer, September, October and November are autumn, December, January and February of the following year are winter)

C. Method

1) NDVI trend analysis: A least-square regression model**[6]**was used indetecting the gradual changes in the NDVI trend.

$$y_t = a + bx_t + \varepsilon \; x_t \in \{1.......N\} \quad (1)$$

Where y_t represents the NDVI time series, x_t is the time, *a* and *b* are the regression intercept and trend (slope)respectively, while ε is the residual of the fit. The trend NDVI were calculated and mapped by pixel.

2) The NDVI response to climate eleme- nts: To analysis the relationship between NDVI and climate elements and separate as many effect of human activities we can, we selected a sample of areas throughout Guizhou province . These regions of interest (ROIs) were chosen aiming to represent locations where significantly increase or decrease trends in NDVI were found, including 7 kinds of land cover except cropland and urban. Finally, we have close 163 ROIs, 84 in the area of NDVI significantly decrease and 79 in NDVI increase(Fig.Ⅱ).

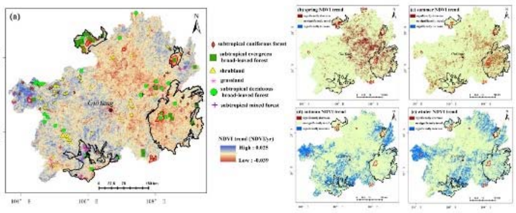

FIGURE II. THE NDVI TREND FROM 2000 TO 2015 AND SPATIAL PATTERN OF THE REGIONS OF INTEREST. THE LEGEND SHOWS THE TYPE OF LAND COVER.

III. RESULTS

A. *The Relationship between NDVI and Land Cover Change*

1. In NDVI significantly decrease area

The two common driving land coverage change factory include urbanization, water management in area which vegetation has significantly decrease. NDVI changes driven by urbanization procession were identified in 757.8km^2, of which 749.9km^2 were associated with a decrease trend and 7.2 km^2 were with an increase trend. There were two major types of trends identified in urban areas: a sharp decrease in NDVI values in cities experiencing urban growth in areas that were previously covered by native vegetation included transformed from cropland was 538.22km^2, forest was70.4km^2,shrub land was 58.4 km^2 and grass was 82.9 km^2 respectively (i.e., urban expansion, e.g., in the middle of the Guizhou province of Guiyang. The new development have been established for 2009,when forest was transformed bare land, NDVI in black line quickly decrease from 2009 to 2011,Fig3c. After 2013, the land unused were gradually transformed building lead to NDVI decrease quicklyFig.Ⅲ, followed by an increase in NDVI values as vegetation (i.e., urban greening, in the area of black line, forest that not was transformed urban are used urban green and NDVI is becoming higher and higher, lead to standard deviation in black line gradually increase;Fig.Ⅲc).

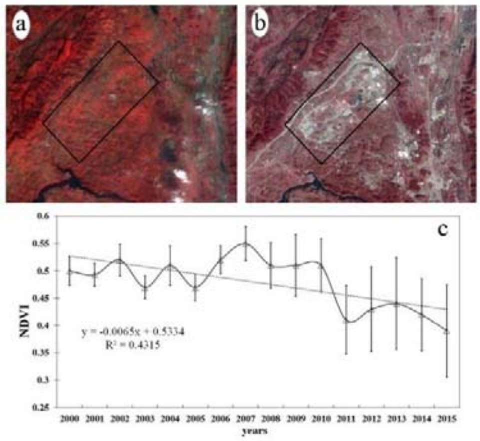

FIGURE III. URBAN EXPANSION AND GREENING IN THE SOUTHWEST OF GUIYANG, CENTRAL GUIZHOU. (A)LANDSAT-5 TM (2000);(B) LANDSAT-8OIL (2014);(E) THE NDVI TREND FROM THE MODIS NDVI 14YEARS TIMESERIES (MEAN VALUES OF NDVI IN THE ROI .

The second most common factor driving NDVI changes was water management to the establishment of reservoir (area=179.4km^2),Landuse changes related to water management belonged to the conversion of crop fields and forest into water(as in the construction of new reservoir near Liuzhi and Anshun, the southwest of Guizhou province, resulting in NDVI values significantly decrease , slope=0.018， R^2=0.75;Fig.Ⅳ).

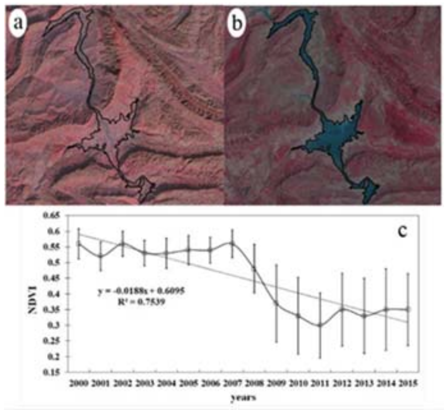

FIGURE IV. WATER MANAGEMENT IN THE LIUZHI, SOUTHWEST GUIZHOU. (A)LANDSAT-5TM(2000);(B) LANDSAT -8OIL (2014);(C) THE NDVI TREND FROM THE MODIS NDVI 14YEARS TIMESERIES (MEAN VALUES OF NDVI IN THE ROI).

2. In NDVI significantly increase area

The only factor driving land cover changes in NDVI significantly increase area was related to ecological afforestation (953.26km^2), with all of them exhibiting the significantly increase of NDVI (due to carrying out the projection of rocky desertification control, cropland convert to grass or forest, e.g. in southwest part of Guizhou province, Huajiang demonstration zone, the mean slope of NDVI increase is 0.0059 in black line,R^2=0.43; standard deviation has become smaller and smaller indicated vegetation has been recovering, Fig.Ⅴ) .

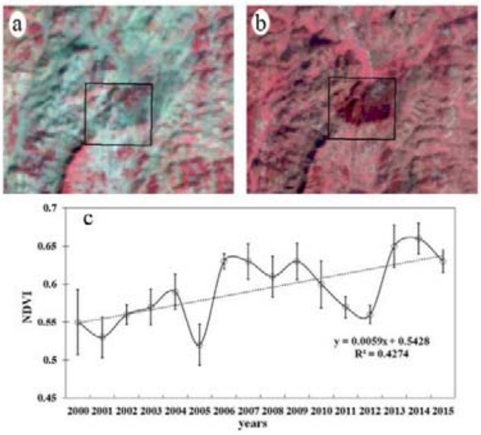

FIGURE V. ECOLOGICAL AFFORESTATION IN THE KARST RESTORATION AREA OF HUAJIANG, SOUTHWEST GUIZHOU. (A)LANDSAT -5TM (2000);(B) LANDSAT-8OIL(2014);(C) THE NDVI TREND FROM THE MODIS NDVI 14YEARS TIMESERIES IN THE ROI.

B. The Effect of Climate on Change in the Forest NDVI

To avoid the interference of human factors, our study has carried out in 163 ROIs where have no land cover change when analyzing NDVI-climate relationships. The follows:

1. In the area of NDVI increase trend, the relation between NDVI values and climate factors were no signification. When examining the relationship between annual mean values of climate factors and NDVI values, there were hardly an ROI that were above 0.5 and climate change significant at P<0.01. In the season scale, There have little or no of ROIs that correlation coefficient values were above 0.5 and climate change significant at P<0.01 between seasons mean temperature and seasons mean NDVI values，Fig.Ⅵ.

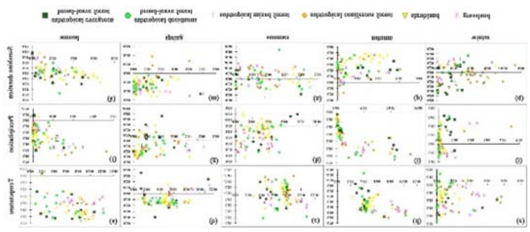

FIGURE VI. THE CORRELATION COEFFICIENTS OF THE 79 ROIS (AMONG TEMPERATURE, PRECIPITATION, SUNSHINE DURATION AND NDVI IN INTER-ANNUAL AND 4 SEASON), AS A FUNCTION OF THE LEAST SQUARES SLOPE SIGNIFICANT (F_TEST). ALL OF THE TRENDS IN THE 79 ROIS WERE SIGNIFICANTLY INCREASE (F>4.6, P<0.05).

2. In the area of NDVI decrease trend, we calculated the correlation coefficient between NDVI and climate elements included annual and seasonal values respectively in 84 ROIs. The result shown that the correlation coefficient between annual mean NDVI values and climate elements are all lower than 0.5, though annual mean temperature and sunshine during are significantly change from 2000 to 2015.The mean that in the inter-annual scale, the impact of climate change on NDVI is weaker.

However, in the seasonal scale, When examining the relationship between summer mean temperature and summer NDVI values, negative correlation values Less than -0.5 (p<0.1)were found in 18 of the 84 ROIs,Fig.Ⅶ.

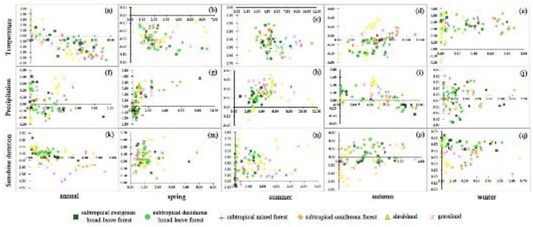

FIGURE VII. THE CORRELATION COEFFICIENTS OF THE 84 ROIS (AMONG TEMPERATURE, PRECIPITATION, SUNSHINE DURATION AND NDVI INTERANNUAL AND 4 SEASON), AS A FUNCTION OF THE LEAST SQUARES SLOPE SIGNIFICANT (F_TEST).

IV. CONCLUSIONS

(1)Karst southwest China experienced significant vegetation changes from 2000 to 2015, which was significantly different in various season. Areas with significantly increased NDVI values comprised 7.8% of the total research area, and vegetation cover in 11.5% of the study area had severely decreased.

(2)The relation between NDVI and climate variation was weaker in the region scale.

(3) The impact of human activities on vegetation dynamic is bidirectional. The negative influence is bigger than positive.

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