Spati-temporal Changes of NDVI and Their Relations with Precipitation and Temperature in Yangtze River Catchment from 1992 to 2001

ZHANG Li[1], CHEN Xiao-Ling[1, 2]

1State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing (LIESMARS), Wuhan University, P.R. China, 430079

Email: sabrinazhangli@hotmail.com

2Key Laboratory of Lake Poyang Ecological Environment and Resource Development , Jiangxi Normal University, Nanchang, P.R. China, 330022

Telephone: 86-027-68778321

Fax: 86-027-68778229

Email: cecxl@yahoo.com

1. Introduction

Vegetation typically shows the seasonal and annual dynamics. The daily temporal resolution and globe coverage of satellite sensors NOAA AVHRR makes it possible to monitor vegetation at different spatial and temporal resolutions globally (Ma et al, 2005). Normalized difference vegetation index (NDVI) data collected by AVHRR sensor, have been widely used to study vegetation dynamics on the earth. Investigating the long-term variations in both vegetation condition and climate change is a good method to monitor the changes of the environment of the globe.

Yangtze River is the longest river in China. Research to the NDVI dynamics in a long time and relationships between the vegetation and climate factors in the regional scale is of significance to monitor the environmental changes in the watershed.

Many research works have focused on the dynamic relations between vegetation and the climatic factors in large regional scale. Herrmann et al. (2005) analyzed the trends in vegetation dynamics in the African Sahel and their relationship to climate. Li et al (2000) and Sun et al (1998) et al. chose the typical vegetation types and representative areas in China which is sensitive to the regional environment to do the analysis. Chen et al.(2001) studied the driving force of the climate factors to NDVI values .Ma et al. (2006) analyzed inter-annual variability of vegetation cover and the relation of NDVI and meteorological parameter in Heihe River Basin in China. Li and Yang(2004) divided Yellow River Basin by 16 sub-regions to analyze the relations between NDVI and precipitation and runoff values.

In this paper, the authors selected a time series of 1km *1km monthly NOAA NDVI from 1992 to 2001, and collected the 235 monthly precipitation and temperature stations data from the World Meteorological Organization (WMO) website. Two kinds of methods are employed in the study to do the statistical analysis. The author analyzed the annual and monthly changes of vegetation in these areas by

NDVI, as well as the relations between the NDVI value and climate factors in different sub-regions in the Yangtze River Catchment.

2. Methods

2.1 Data preprocessing

Maximum Value Composite (MVC) method and Kriging Method was employed to do the data preprocessing.

2.2 Two kinds of Methods to do the statistical analysis in the study area

One is analyze the monthly data in the whole study area to do a total trend analysis in Yangtze River Catchment.

The other is dividing the study area into 5 terrain features with different elevations mainly depending on the DEM data from the SRTM project in this area.

2.3 Calculation Methods

Several statistical methods, including Sample Transect Analysis, Partial Correlation Analysis and GIS Spatial Calculation, were employed to analyze the relationships between NDVI and Climate factors.

3. Results

A total trend of the NDVI dynamics in the study area and the relations between the NDVI and climate factors were shown as follows.

3.1 Variation of monthly mean NDVI values, rainfall, temperature in Yangtze River Catchment from 1992 to 2001

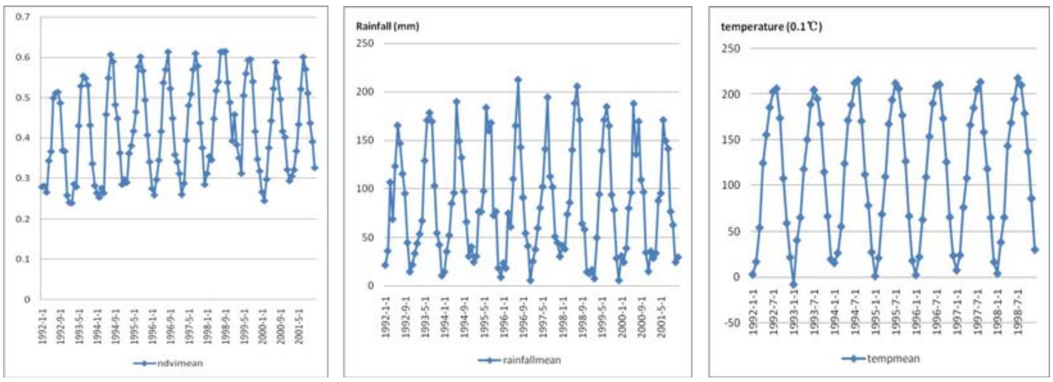

Fig1 Variation of monthly mean NDVI values, precipitation, temperature in Yangtze River Catchment from 1992 to 2001

Figure 1 showed that NDVI sligtly increased and precipitation fluctuated during the ten years while temperature remained stablely with little increase in the study area.

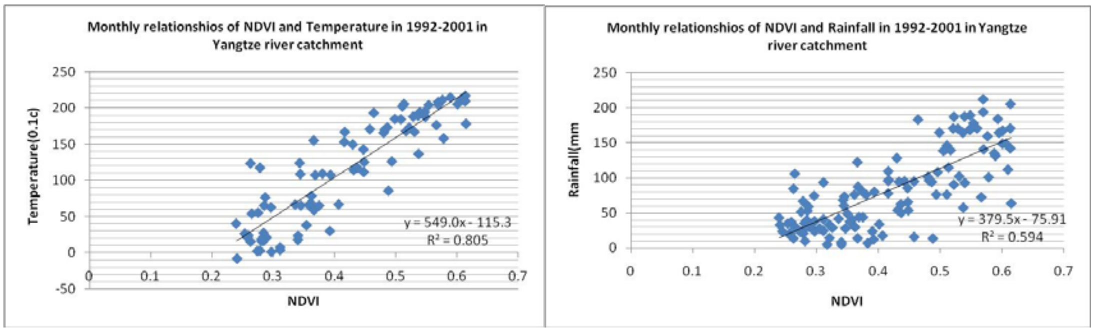

Fig2 scatter plot between the NDVI and rainfall and the NDVI and temperature

Figure 2 showed that NDVI values had a linear relation to the climate facors where temperatrue had a high correlation to the NDVI values while the correlation of rainfall was relatively low to the regression curve.

3.2 Relations of NDVI, precipition and temperature in a year.

Year	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Rainfall	June	July	June	June	July	July	July	July	June	June
NDVI	Augest	Augest	July	Augest	Augest	Augest	July	Augest	July	July
Temperature	Augest	July	Augest	Augest	Augest	Augest	July	Augest	July	July

Table 1 Occurrence of the peak values of NDVI, precipitation and temperature in a year.

From Table 1, we can find that the peak value of NDVI had a consistent time lag with the peak value of precipitation, but showed an obvious consistent trend with the peak value of temperature, which suggested that temperature might be a major factor to the vegetation growth in the study area.

3.3 Sub-regions with four typical terrain features are presented

plain area with a elevation range between 0-50m,the upland area of 50-200m,the low mountain area of 200-1000m, middle mountain area of 1000-3000m which are the four major landform in the study area.

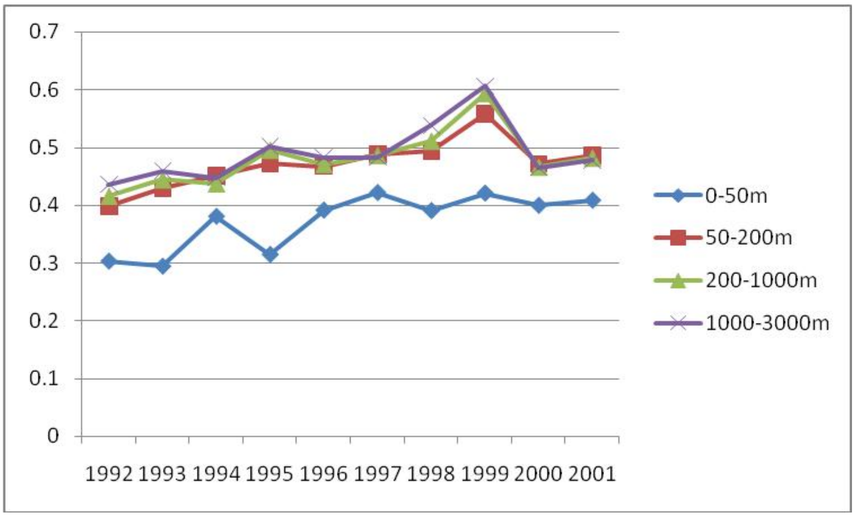

Fig 3 Yearly vegetation cove change at upland area and mountain area from 1992 to 2001

From Figure 3, we could conclude NDVI value in the mountain areas is universally higher than the plain area. The mountain areas above 50m have a similar trend while the plain area is different.

The vegetation cover from 1992-2001 shows an increasing trend in all the sub-regions as you can see from Fig 3.

Table 2 showed the correlative coefficient among NDVI, Temperature and Precipitation from 1992 to 2001, which showed that temperature was more sensitive to NDVI in all the sub-regions while the high mountain area is excluded. The correlation is low between climate factors and vegetation in lower areas which have an elevation value lower than 1000m, especially for the precipitation. And the relation between NDVI and both the temperature and precipitation have a higher correlation at Middle mountain area with an elevation range of 1000-3000m. In High mountain area precipitation plays a dominant role to the vegetation cover.

Terrain feature	Plain area(0-50 m)	Upland area(50-200 m)	Low mountain area(200-1000m)	Middle mountain area(1000-3000m)	High mountain area(>3000 m)
Rainfall	0.139	0.180	0.170	0.609	0.714
Temperature	0.380	0.333	0.543	0.717	0.240

Table 2 Correlation among NDVI, Temperature and Precipitation of different terrain features

4. Conclusion

In general, NDVI in the whole Yangtze River Catchment and all the sub-regions reaches peak value in July or August within a year. In the study time period from 1992 to 2001, the NDVI values showed an increasing trend in August.

Precipitation and temperature showed a linear correlation with NDVI value in the whole Yangtze River Catchment, while temperature influence is larger than the precipitation in the whole catchment.

Precipitation showed a lag effect on the NDVI at a year scale.

According to the results in the 5 sub-regions divided by the terrain features, the NDVI values shows a increasing trend from 1992 to 2001 and mountain areas gives a higher values than the Plain area. This suggests that human activities such as urbanization play an important role at the vegetation cover in plain area while nature features have more positive effect in mountain areas.

Both precipitation and temperature had different effects depending on different types of landform. Temperature had more significant effect in all the sub-regions' vegetation cover. In the lower area where the elevation value lower than 1000m, Climate factors have a slight effect to the changes of vegetation cover especially for the precipitation. But in the middle mountain area with an elevation range of 1000-2000m, Climate factors play an important role to the changes of vegetation cover. In high mountain area precipitation dominants the changes of vegetation cover while temperature has little effect on the vegetation cover.

5. Acknowledgement

This work was funded by the 973 Program (Grant No.2006CB701300), the Program for Changjiang Scholars and Innovative Research Team in University (Grant No. IRT0438) and China / Ireland Science and Technology Collaboration Research Fund.

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