ASSESSING THE DROUGHT MONITORING CHARACTERISTIC OF TIME-SERIES NDVI INDICES IN CROP GROWING SEASON

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1. INTRODUCTION

Drought monitoring is difficult due to the immense spatial and temporal variability exhibited by each drought event [1]. Therefore, a single method is not enough to precisely characterize and monitor drought. It has been demonstrated that the Vegetation Condition Index (VCI) and phenology metric called Percent of Average Seasonal Greenness (PASG) which are based on time-series NDVI could be used for monitoring crop condition [1]. Besides, recent research has found that the Standardized Precipitation Index (SPI) has many advantages in detecting emerging drought. Climate- and satellite-derived indices have close links with each other [2], but the relationship is very complex. The influence of precipitation on crop is not constant at different periods of the crop growing season. Also, changes of crop conditions can result from other natural and anthropogenic events [3-4]. However, few studies have examined the effectiveness of using VCI and PASG for drought monitoring within different phonological periods of crop growing season. The objective of this paper is using time-series NDVI and meteorological data to analyze: (1) the relationship between VCI, PASG and multi-scale SPI in crop growing season; (2) at which stage of crop growing season are VCI and PASG much appropriate for drought monitoring; (3) how effectively VCI and PASG are used for drought monitoring in crop growing season.

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2. STUDY AREA AND DATA

The study area is located in the south of the Huang-Huai-Hai region in the north of China. Cropland makes up most of the land cover in this region. There are 11 meteorological stations covered by the crop area. Historical record of ten-day precipitation (1960-2008) of each station was acquired from China Meteorological Data Sharing Service System. We used the MODIS Terra Land Cover Type Yearly L3 Global 1 km SIN Grid 2008 product (MOD12Q1) to locate cropland cover type in the study area. SPOT VGT-S product (1×1 km, ten-day MVC Product) during the period from January 1999 to December 2008 was used to construct a high-quality time-series NDVI dataset. Then the VCI and PASG were computed using the processed time-series NDVI data.

3. METHODOLOGY

3.1. Savitzky-Golay Filter

A simple but robust method developed by Chen [5] is based on the Savitzky-Golay filter to smooth out noise in time-series NDVI values. A total of 10 years time-series NDVI from 1999 to 2008 is processed by this approach. Considering vegetation growth cycle, this method can successfully reduce the influence of cloud contamination and atmospheric variability.

3.2. Piecewise Logistic Functions

Crop phenology was represented using a series of piecewise logistic functions of time using processed time-series NDVI products [6]. The onset and end of greenness are identified by the rate of change in the curvature of the fitted logistic models. Then the seasonal greenness (SG) metric for every ten-day of the growing season for all 10 years time series was calculated by integral method for the fitted logistic functions.

3.3. Calculation of VCI, PASG and SPI

VCI [7] was calculate using the time-series NDVI value processed by the Savitzky-Golay filter approach. PASG was calculated by Equation [1] :

$$PASG_{PnYn} = (SG_{PnYn} / xSG_{Pn})*100 \quad (1)$$

Where SG_{PnYn} refers to the SG for a ten-day period (Pn) of a specific year (Yn) and xSG_{Pn} is the historical average $SG(x)$ for the same ten-day period (Pn). Multi-scale SPI (1-month, 2-month, 3-month, 6-month, 9-month and 12-month) was calculated using the ten-day precipitation (1960-2008) data. Then 14 ten-days from the last ten-day of May to the first ten-day of October during crop growing season in 2008 were selected as the study period. SPI and median VCI, PASG at the corresponding time were extracted by use of 9km*9km window at 11 station locations. Lastly, we analyzed the relationships among the three of them.

4. CONCLUSIONS

Only the trends figure of time-series NDVI and coefficients between VCI, PASG and 1-month SPI are shown below:

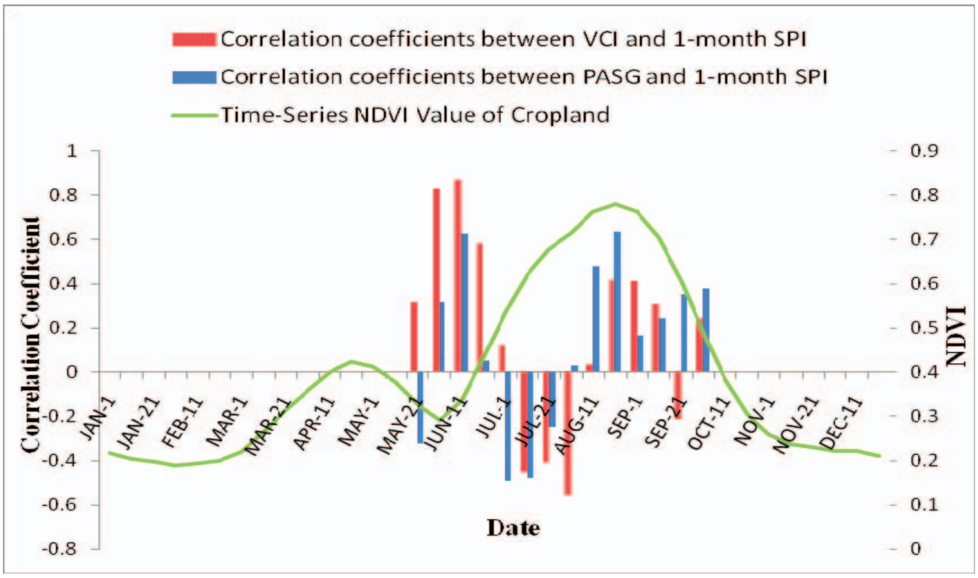

Fig.1. The trends of time-series NDVI and correlation coefficients between VCI, PASG and 1-month SPI.

From the results obtained in this study, conclusions are drawn as follows: (1) the change of correlation coefficients between VCI, PASG and multi-scale SPI have a close relationship with the crop system and the crop growth cycle in Huang-Huai-Hai region. At different periods of the growing season the effects of drought monitoring using VCI and PASG are not the same. The purpose of the real-time drought monitoring can be achieved at the three periods i.e. the time from the last ten-day of May to the middle ten-day of June, the mid-to-late August and the mid-to late September. Therefore, at the other periods of the growing season using time-series NDVI indices for drought monitoring, not only surface types but also the crop system, phenology and other man-made irrigation, climatic factors should be considered. (2) In the critical period of crop water requirement, VCI, PASG and 1-month SPI-scale have a better correlation. (3) During the best period of carrying on the remote sensing inversion for drought monitoring, both VCI and PASG can achieve the objective of the real-time drought monitoring. VCI presents the rapid change along with the different levels of crop water demand, but PASG maintains a smooth effect of drought monitoring during the three crucial periods for water demand. Besides, both of them have a very good complementary for each other.

5. REFERENCES

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