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The Study of Dynamic Monitor of Rice Drought in Jiangxi Province with Remote Sensing

Zhang Xiu-Ping[a]*,Li Rong-Fang [a, b], Lei Sheng [a],Fu Qun[a], Wang Xiao-Xiao[a]

[a]Jiangxi Provincial Institute of Water Sciences, NanChang, 330029, China
[b] *Donghua University College of Information Science and Technology, Shanghai 201620[a]*
LeiChen1980@yeah.net

Abstract

MODIS sensor has a high temporal resolution, spectral resolution, and moderate spatial resolution. The data products are widely used in Large-scale and long period dynamic monitoring of drought. This paper focuses on characters of farming rice dominated in Jiangxi province, and analysis on remote sensing monitoring model and drought monitoring indicators which selection the MODIS data products and drought information related from 2000-2008. Established standard for classification of drought in Jiangxi province, and verified instances of 2003 drought in Jiangxi. This study may have a certain significance to agricultural drought monitoring based on rice planting in southern China, because the correspondence match between the selected TD indices and cloud cover with precipitation and daily maximum temperature evolution curve.

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Keywords: Remote sensing，Rice，Drought， MODIS.

Ⅰ. Introduction

Jiangxi is a major agricultural province, the area of Jiangxi's rice planting stands second among China's provincial capitals, and the rice yield is ranking third. It is only one of the two provinces which uninterrupted provide commodity grain to the State. It has an important strategic position to ensure national grain production safety. However, Jiangxi is a frequent drought province. According to the statistics of the province over the drought situation, drought in Jiangxi Province is mainly agricultural drought, local agricultural drought occurred almost every year, serious drought in the province have occurred.

The remote sensing monitoring of drought can get frequent and sustained information on the surface characteristics of planar with full useing information of ground surface spectrum of time, space and

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direction. It can provide macro, dynamic and real - time monitor data source for real - time and dynamic monitoring of drought.

Chinese scholars has been made a lot of research methods in drought remote sensing monitoring, but the remote sensing method is still rare suitable for Jiangxi Province which mainly grow rice.

1.The rice drought indices selection in Jiangxi

Although there are many drought monitoring methords had been created, many of them have to meet certain conditions,e.g. , The region which use vegetation supply water index, vegetation Temperature condition Index or temperature/vegetation dryness index to inversion the drought level must have dry and bare soil, wet bare soil, vegetation by water restrictions and vegetation which growing well with adequate water. crop shortage water index considers the vegetion,surface wind speed,water vapor and other factors,it have a good performance at monitoring the large plains' drought at vegetation season,but it involve many factors that is come from different sources and different structures, and it have a great computaional,so it is not suitable for large area micro-climate differences region,forthermore , some factors rely on ground meteorological elements, so it can not guarantee real-time [1]; Thermal Radiant Directionality is mainly used for bare dry. For the major indexes of drought mointor exitingly ,there are many shortages of them, e.g. NDVI values can reflect the the growth of crops, but crops growth change from drought have a certain time lag, the current growth monitoring is the summary Status of pre-drought . For VCI or TCI drought monitoring indicators, the ground of study area must contain the wilting water content and full water holding capacity content during the VCI or TCI indicator's cross-year. And they are affected by seasonal and the interannual variation of vegetation type.

Jiangxi agricultural is mainly to grow rice, and drought occurred in June ~ October, especially July and August are strong growth period of rice, the main drought monitoring method and indices more or less restrictive in dynamic monitoring of rice in Jiangxi.

1 *The relationship between canopy temperature and water stress*

When soil water content is lower, the plant leaves can reduce moisture loss with Transpiration by closing stomatal. That lead to cut down surface latent heat fluxes and increas surface sensible heat fluxes, which caused canopy temperature rising. Vegetation canopy temperature rise that mean plant got water stress. Average canopy temperature of different rice varieties have shown an upward trend during stress period. Canopy temperature of water stress is higher than no stress, and there are 1.5~5.0℃ difference between no stress and severe stress[2]. So canopy temperature can be the first drought indicators in a rice areas.

However, the canopy temperature on different rice variety has very significant difference in period of water stress, the variety which high canopy temperature in severe water stress that get high canopy temperature under the conditions of irrigation [2], therefore, just simple using canopy temperature as rice regional drought monitoring model that would be effected by different rice varieties.

2. Day-and-Night Temperature Difference

Surface temperature is a good indicator for the earth's surface energy balance and the greenhouse effect, it is good to reflect the drought situation particularly in the city and the waters near. The day and night temperature difference of water is less than city. The day and night temperature difference has a very strong relationship with the soil moisture in surface from 0-100cm, the drought will be more serious when the temperature difference increasing and the moisture content decreasing. The day and night temperature difference can use to study on drought at cloudless sunny day. For larger area, that cann't access to the entire area ground information, because one day remote sensing images often affected by

cloud. The cloud easily made errors cause of low brightness temperature on thermal infrared channel, so it must doing Cloud removing before calculating the day and night temperature difference.

Clouds

Rainfall plays a very important role to relieve the drought. The cloud is very important in drought monitoring as the main source of precipitation, meanwhile, the cloud is absolutely necessary as drought monitoring indicator, because the cloud cover can effectively reduce ground receiving solar radiation and evapotranspiration. In remote sensing image , precipitation has very low cloud top temperature, large size and thick clouds, and non - precipitation cloud top temperature is closing or slightly below the surface temperature, higher brightness temperature and light cloud that will not formation of rainfall.

Case Study

Case

MODIS data have 36 bands, this multi-channel observation greatly enhanced its capacity on observing the complex systems of the earth and the ability to identify the type of surface. It can be get 4 images every day in the same region-2 for day and 2 for night. This data is free to receive and free to use, it meet the daily needs of the dynamic drought observation. We use 8-day Synthetic land surface temperature products of MODIS in this study, time range from July to September between 2000 to 2008, its spatial resolution is 1km.this data including surface temperature during the day and night and 31-32 band Emissivity. These data were downloaded from U.S. LPDAAC (Land Processes Distributed Active Archive Center, USA) data center. Through the analysis of the relationship between temperature and rice drought in JiangXi province, we established drought classification standard with the Indicator TD which is the temperature difference between day and night in Table 1.

Table 1 TD drought classification standard in JiangXi province

Indicator	Too wet	nor mal	Mild drought	Moderate drought	Severe Drought
TD	≤2	2～7	7～9	9～11	≥11

Cloud is another indicator of drought too, it also plays a very important role in drought monitoring. When there are low temperature clouds in remote sensing image , it indicating the occurrence of rain and lower drought level. The high temperature of the thin cloud, which temperature often slightly lower or equal to the ground often plays an important role in drought monitoring, although it is not indicating the occur of rain, it help to shield the sun and reduce the surface evapotranspiration.

Analysis

In the summer of 2003, Southern China was suffered a wide range of high temperature and drought which is rarely seen in history. JiangXi province which is also in high temperature zone in southern, also suffered abnormal high temperature and dry summer weather since the establishment of China, and the drought continued into the winter .Because of the sustained high temperatures in JiangXi Province, many index of drought meteorological and drought index breaking the historical record. Form July to August, 58% of the area in Jiangxi Province suffered severe drought, and the southern was sever than the northern. The wide range of high temperature and drought level, the length of time and the severity of disaster is rare for the same period of history. So we select 2003 for analyze year.Fig. 1 shows the summer of 2003 in Jiangxi Province performed daily maximum temperature and precipitation evolution diagram. It can be divided the high temperature periods into three part, the main high temperature period was from July 13

to August 22, sub-high temperature period from June 29 to July 12, and the last period was begin from August 22. During this period , there were two major Rainfall period , one was from July 5 to July 8, the average temperature in the province is lower then 34 Degrees Celsius, one was from August 11 to 22, due to slightly weaker of Subtropical climate and Artificial rainfall, some region of JiangXi was rain and the maximum temperature also decreased.

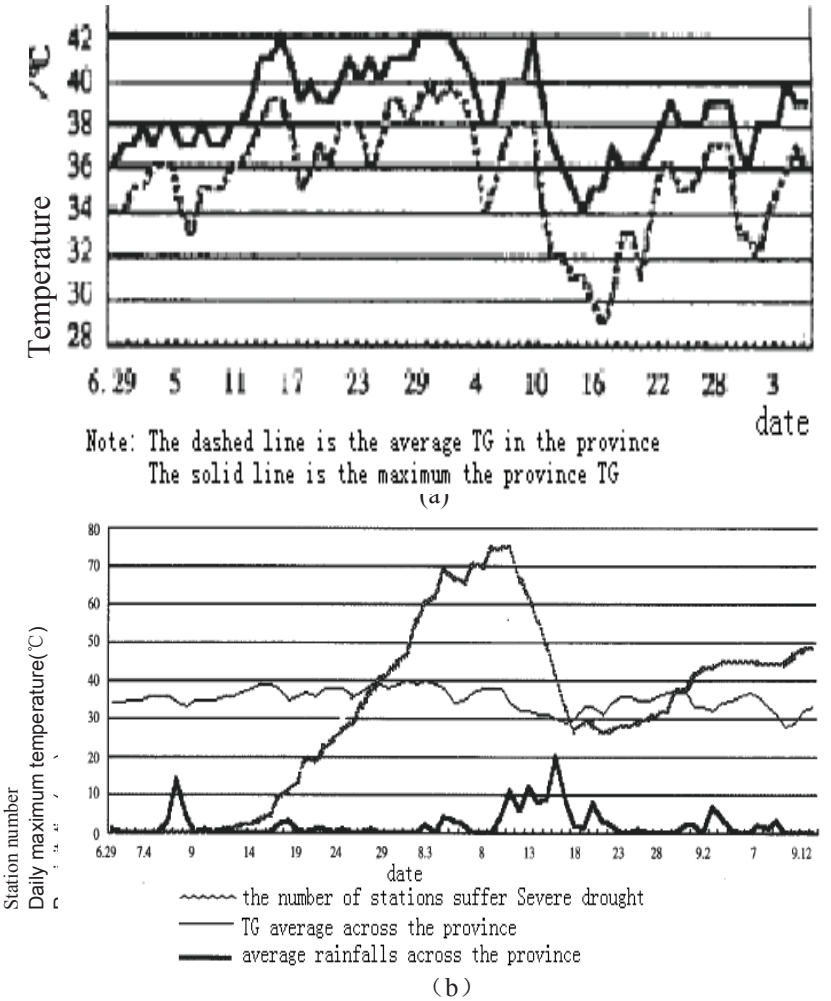

Fig. 1 Daily maximum temperature and precipitation evolution diagram in the summer of 2003 in Jiangxi Province

Note: figure (a) is quote from "Climate Attribute and Clause Analysis Of Jiangxi Abnormal High Temperature In Summer In 2003" [3] and Figure (b) is from "study of the summer drought trend monitoring index " [4]

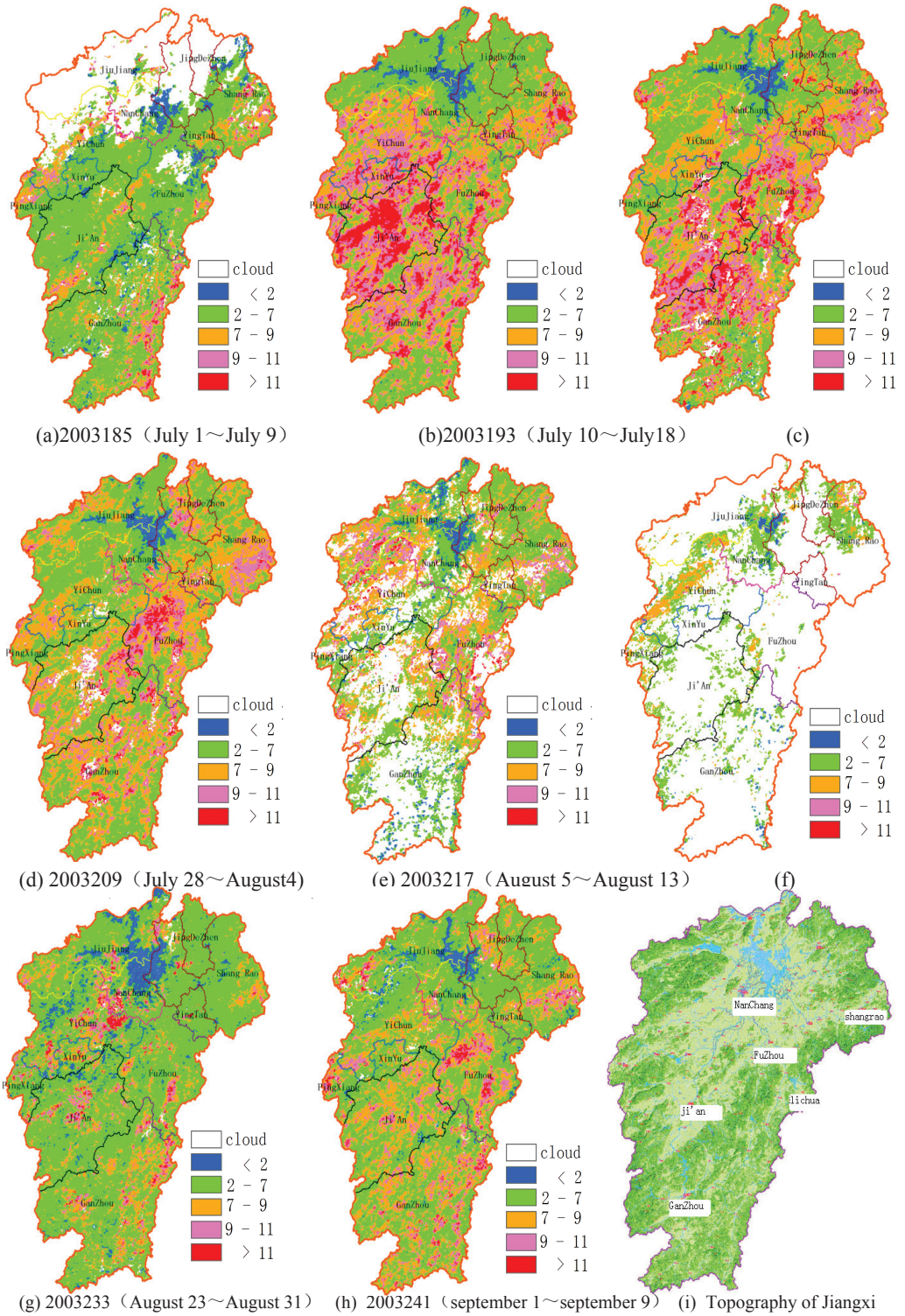

Fig. 2 Distribution of drought with TD Rating during July to September of 2003 in JiangXi province

Fig. 2 shows the distribution of drought during July to September of 2003 in JiangXi province, which is inversion by the TD index. It can be seen that:

(1) From figure (a), which is the composite TD image of July 1 to July 9, we can see that the drought did not happened during the period of July 1 to July 9 in most of JiangXi province, Jiujiang, yichun, jingdezhen, nanchang and west of shangrao were covered with large cloud, it means there were rain at that region.

(2) After July 9 the temperature continued to rise, the temperature reached the highest value from July 13 to July 17 , it also had less rainfall in additional. High temperature and dry weather prevailed in the high-value until August 2.In the period after July 17, the temperature dropped slightly, and we can also seen from the drought image (b)~(d) that drought level in this period is the most serious in July, and this drought weather continued to early August.

(3) At about August 4, the average of temperture in the province had been a small declide, and there is a slight rainfall occurred too. From figure (e),we can see than, parts of the province had scattered cloud distribution, especially in Ganzhou, Ji'an and other places have a large area of cloud coverage. from August 11 to 22,due to slightly weaker of subtropical weather and artificial precipitation, some region of JiangXi was rain and the maximum temperature also decreased. In the composite TD image (f) of August 14 to August 22,most areas of JiangXi province was covered with cloud, it also indicated that the drought level had decreased. Temperatures rose again in the late August, However ,in this period, large areas of the province had just occurred rainfall, drought did not immediately move up, which is also match the TD drought level images' result. After August 23, with the restore of dry weather, in addition with the gradual rise in maximum temperature, drought also had an upward trend again like figure (f)~(i) show.

The above analysis shows that the correspondence match between the selected TD indices and cloud cover with precipitation and daily maximum temperature evolution curve. It is suggested that the drought index designed scientific and rational, and also realistic.

Summary

(1) Many of the current drought monitoring method are design to use in monitoring ring northern crop， these methods have been generally adequate to meet demand. There are many hills and mountains at south, so the climate and geomorphology is more complex, and there are less methods had been designed for the South, especially for rice area, and the effect is not very satisfactory. By analys the relationship between canopy temperature and MODIS TD data during 2000 to 2003, we found that TD index can be a good indicator on reflecting the distribution of drought in Jiangxi Province, so we established a drought monitor method of rice region in Jiangxi Province with TD index, this method is very simple and it has certain significance on monitoring of agricultural drought in JiangXi Province where is mainly in rice cultivation.

(2) Within the existing Drought monitoring model, cloud often have to removed and it can not get the status of drought at the region where is covered by cloud. This article we introduce the cloud coverage of the drought monitoring in Jiangxi Province, it solved the problem which can not monitor the drought situation because above by cloud. it also has great effect for the drought in Jiangxi.

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