SEMI-REAL TIME MONITORING SYSTEM FOR AGRICULTURAL DISASTERS USING NOAA/AVHRR DATA

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ABSTRACT:

To use of remote sensing techniques for Agricultural monitoring, it needs semi-real time data acquisition, treatment, and distribution. For this reason we are now developing Satellite Image Data Base System (SIDaB). First, I introduce our SIDaB system, and our future plane of satellites data acquisition. Using network system such as Asia Pacific Advanced Network (APAN), we get NOAA/AVHRR, TERRA&AQUA/MODIS and DMSP/OLS data in semi-real time.

Next, I mention about vegetation monitoring system. We are also developing Agriculture -monitoring system in East Asia using NOAA/AVHRR data. Every ten days maximum Normalized Difference Vegetation Index (NDVI) is compared with past three years average of ten days maximum NDVI value. The standard ten-days NDVI images are created using the ten-days data of 1997-1999. To reduce the cloud noise, the maximum value of NDVI is used for ten-days composites. When the average value is calculated, the minus NDVI pixels are eliminated, since there is the cloud pixels even in ten-days composite. Then, the difference NDVI images between the standard ten-days NDVI images and up-to-date ten-days NDVI images are calculated. Using these difference NDVI images, it is possible to detect the area of drought damage on agriculture. The minus difference (<-0.1) pixels are listed as drought risk area in spring and summer.

1. INTRODUCTION

In recent years, the satellite, the computer, and network technologies have been developed in each year, and these technologies have been used popularly. NOAA satellites provide a regular, repetitive view of nearly the earth's entire surface (Johnson et al. 1993). Many researches have been carried out on regional and global land monitoring using NOAA/AVHRR data. The AVHRR-based reflectance in the visible (VIS) and near-infrared (NIR) wave bands and the Normalized Difference Vegetation Index (NDVI) has been used for drought monitoring (Kogan 1987, 1994, 1995 and 1997).

Agriculture monitoring is important for estimating for crop productions and detecting agricultural disaster such as droughts and floods. Therefore, the objective of this study is to develop and establish the monitoring agriculture system in East and South East Asia using NOAA/AVHRR data. The system is developed using the changes of up-to-date and normal NDVI from AVHRR data. Using this system, the drought effects on agriculture in China 2000 year are detected and monitored successfully.

2. USED METHOD, MATERIAL AND SYSTEM

2.1 Methodology

The NDVI is very popular parameter from the satellite data. Many researchers have used the NDVI for monitoring global vegetation and climate studies (Kogan 1990, 1994, 1995 and 1997; Los et al., 1994; Ramsey at al., 1995; Tucker et. al., 1983 and 1985; Walker et al., 1998). It is shown that the NDVI is useful for these researches. In this research, the changes of up-to-date and normal NDVI from NOAA/AVHRR data are used for detecting and monitoring drought effects on agriculture.

Since there are the cloud areas in NOAA/AVHRR data, for detecting and monitoring drought cloud free satellite data are required. Therefore, to minimize the cloud effect, the largest NDVI value of every pixel is used for the daily and ten-days images. Although even using this method, we found that there are too much cloud cover areas in the daily and weekly images, which are difficult to detect drought effects on agriculture using these data. On the other hand, monthly data is too long to describe the development of vegetation because morphological changes and leaf appearances occur at the short period (Illinova 1975). Therefore, in this research, the detection and monitor of drought effects on each ten-days interval are discussed. The outline of this research method and the algorithm of this research are fig. 1. The standard NDVI images are created at first. Then, the up-to-date NDVI is calculated just after the ten days and cloud pixels are masked for elimination. And then, the difference NDVI images between the standard and up-to-date NDVI images are calculated. Lastly, using the difference NDVI image, it is possible to detect the area and intensity of drought damage on agriculture. The bigger negative difference pixels are listed as drought areas, and the values of difference NDVI show the intensities of the drought damages

2.2 Satellite Image Database System in Agriculture, Forestry and Fisheries (SIDaB)

Every monitoring must be performed on time, and it needs semi-real time data for analyzing and old data as standard. For this reason we are now developing Satellite Image Database System (SIDaB) in Computer Center for Agriculture, Forestry and Fisheries Research. SIDaB gathers raw data NOAA/AVHRR data from three receiving stations in Japan one station from Thailand, and process and stores the data. DMSP/OLS data come from National Geophysical Data Center /NOAA using network system such as Asia Pacific Advanced Network (APAN), we get NOAA/AVHRR and DMSP/OLS data on semi-real time.

The NOAA/AVHRR data, which are processed at the Computer Center for Agriculture, Forestry and Fisheries Research, Japan, named as Satellite Image Database System in Agriculture, Forestry and Fisheries (SIDaB) (Kodama et al., 2000). In this system, the user can search and download the satellite images freely using WWW and FTP (http://www.affrc.go.jp/agropedia/).The NOAA/AVHRR data of this system are receiving at three stations of Japan, Shiogama, Yokohama and Ishigaki, and one station of Thailand, Bangkok belonged to Asian Institute of Technology (AIT). These data are transmitted using the high-speed network system, and processed at the Computer Center for Agriculture, Forestry and Fisheries Research, Japan. The geometric correction and mosaic are doing in short time using TeraScan software and EWS. The daily, weekly, ten-days and monthly NDVI, MCSST and other datasets are supplied automatically.

3. RESULTS

3.1 Creating the standard NDVI image

Firstly, we select the suitable period NOAAA data for creating the standard NDVI images. On thinking of climatically periodicity, it seems that the longer time series data are suitable for creating the standard NDVI image. The NOAA/AVHRR data in SIDaB are useful from 1994. However, it is known that clouds and other atmosphere constituents obscure the land surface, reducing NDVI considerably (Goward et al, 1991; Goward et al, 1993; Gutman 1991; Twonshend 1994; Los et al. 1994; Justice and Townshend 1994). Due to a volcanic eruption, the NDVI was depressed for a long time (Kogan et al. 1994). On the other hand, on thinking of agriculture, since there are the annual changes in the vegetation, the too old data are impossible for explanation of vegetation changes. Therefore, considering both two factors above, because the atmospheric state is almost stable since 1997, the NOAA/AVHRR data in 1997-1999 are selected for creating the standard NDVI images.

In order to minimize the cloud effects, the ten-days NDVI images are created using the maximum value of every pixel firstly. Then, the ten-days NDVI images are masked because there are also cloudy pixels even in this method. The cloudy pixels (NDVI < 0) are substituted as the special value areas so that these pixels are eliminated when the averages of NDVI data are calculated. The average values of NDVI data in1997-1999 are that of standard NDVI images. Examples of the standard NDVI images are shown in fig. 2.

3.2 Agriculture Monitoring Using up-to-date (2000 year) NDVI image

The up-to-date NDVI is calculated just after the ten days and cloud pixels are masked for elimination. Similar to the reason described above, there are also the cloudy pixels in up-to-date ten-days NDVI image even using the maximum value of each pixel for the daily and ten-days images. For these areas, it is impossible to monitor the change of vegetation. Therefore, these pixels (NDVI < 0) are substituted as the special value area. In the NDVI image, these areas are shown in gray areas (fig. 3). When the NDVI image is used, these areas will be eliminated.

The difference NDVI images between the standard and up-to-date ten-days NDVI images are calculated, and the drought risk maps are created using this difference NDVI. The bigger difference NDVI pixels are listed as the drought risk areas, and the values of this difference NDVI show the intensities of drought effects. Considering the change of vegetation growth, the drought risk maps are created using the following two calculation methods. The first method is using the value of the difference NDVI between the standard and up-to-date directly (fig. 3). There are 3 classes, >0.1, 0.1~-0.1, <-0.1. Considering the general condition of vegetation growth, < -0.1 classes is listed as poor growth of crops as usual.

3.3 Detecting and monitoring drought in China

China is essentially an agricultural country with about 80 percent of its total population engaged in agriculture. It is the biggest developing country, with the one fifth of the world's population. Anything is bound to affect all over world, especially, the food problem direct affected by agriculture. It is important to detect and monitor the changes of the agriculture in China. In last year (2000), there were heavy droughts in China. In this research, using the early detection system described above, the drought area and intensity are successfully detected and monitored.

Using the agriculture monitoring system described above, the drought risk maps on each ten-days interval in 2000 are created. In this paper, the NDVI difference and intensity in the last ten-days of June and July are described fig. 3. In early June, there were drought possibility areas at Inner Mongolia in China and Mongolia, and then the area extends all direction (fig. 4). The standard, up-to-date, difference and ratio of difference and standard NDVI profiles are created (fig. 5) in the average NDVI values at 10 pixels of every plot (fig. 5). According to these NDVI profiles. Forest Steppe (A and B) has a big peak in July and Desert Steppe (C) has a little high plateau from June to September. We can easily understand to the effects of drought at these plots. Two crops system area in China (D) has two peaks that are winter wheat and rice. At the D of fig. 5, it is almost same 2000 year and average of three years.

In fig. 6, Beijing City was included the drought possibility area, and we checked the precipitation at Beijing. The averages of precipitation in 1997-1999 are calculated, and then compared with the precipitation in 2000, the changes of average, up-to-date and the difference precipitation are shown in fig. 4. From fig. 4, the precipitation in 2000 was less than the average precipitation at Beijing city before July. Due to the little precipitation, the negative difference between precipitation and potential evaporation occurred to drought.

4. CONCLUSIONS

In this research, using the changes of up-to-date and normal NDVI from NOAA/AVHRR data, agriculture monitoring system is developed. The standard ten-days NDVI images are created using the averages of ten-days cloud free NDVI data in 1997-1999. Using this system, we can make the drought risk map. The map is created using the differences between the up-to-date ten-days NDVI images and the standard NDVI images. The bigger negative difference pixels (difference NDVI < -0.1) are listed as the drought risk areas. The drought risk maps in China last year are discussed as the example. Compiling the analyses of characteristics of NDVI profiles and meteorological precipitation data, the drought effects on agriculture in 2000 are detected and monitored successful. It is shown that this system is possible and useful to detect the drought area and intensity on agriculture

□ @ @ JAPAN □ @ ← □ Data & Information Exchange → CHINA

NOAA/AVHRR

NDVI images(10 days composite) □ @ --- □ @ Network --→ Images

NDVI Difference Image of
the present year and average of years --- Network --→ Images

Difference Image of Daytime Temp.
and Night Temp (10 days composite) □ @ --- Network --→ Images

DMSP/OLS

Nighttime light images (10 days composite) --- Network --→ Images

Light changes images (10 days interval) --- Network --→ Images

Monitoring --Comparison with New and Previous
Images, and Interpretation of Images
→ Extract Unusual Area

RADARSAT/SAR, SPOT/HRV or/and Terra/ASTER

Request to RADARSAT International ← - Network---- Determination Observing Area
& Spot Image Inc.

Process SAR images --- Network --→ Images
or/and SPOT/HRV

Interpretation of Fine Resolution Images
--→ Warning and Suggestions

Fig. 1 The Total Study Plan of Agriculture Monitoring Using Satellite Data in East Asia

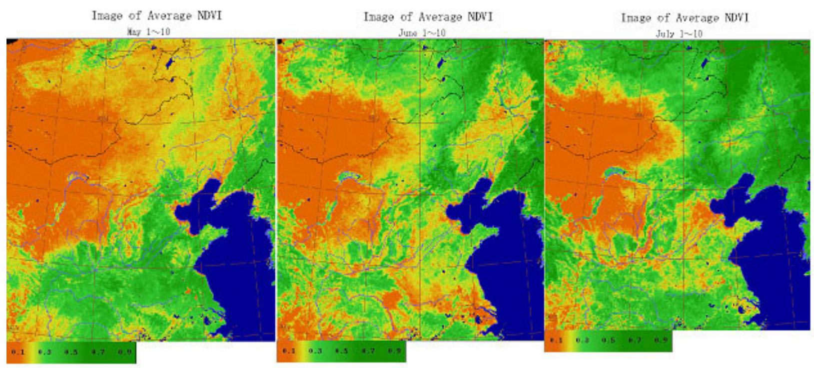

Fig. 2 Average NDVI images between 1997, 1998 and 1999 at early May, June and July

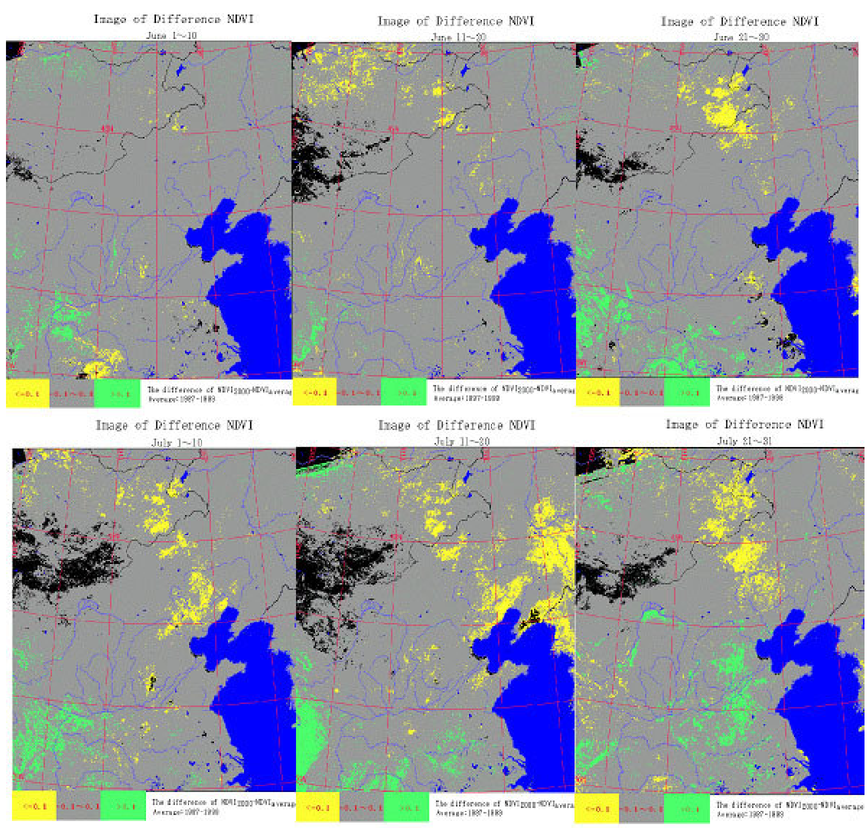

Fig. 3 NDVI difference Image of the present year and average of 1997 – 1999 years

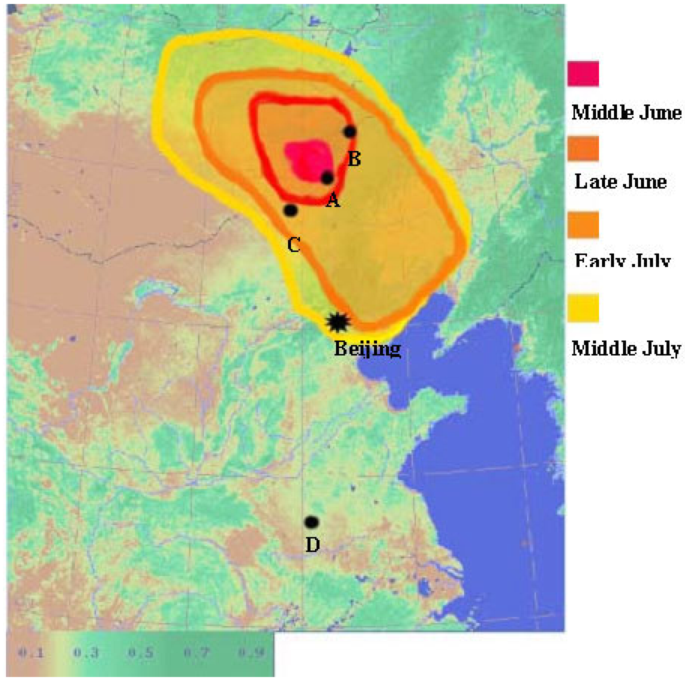

Fig. 4 Drought possibility area at north China in 2000 year by the agricultural monitoring system using NOAA/AVHRR.

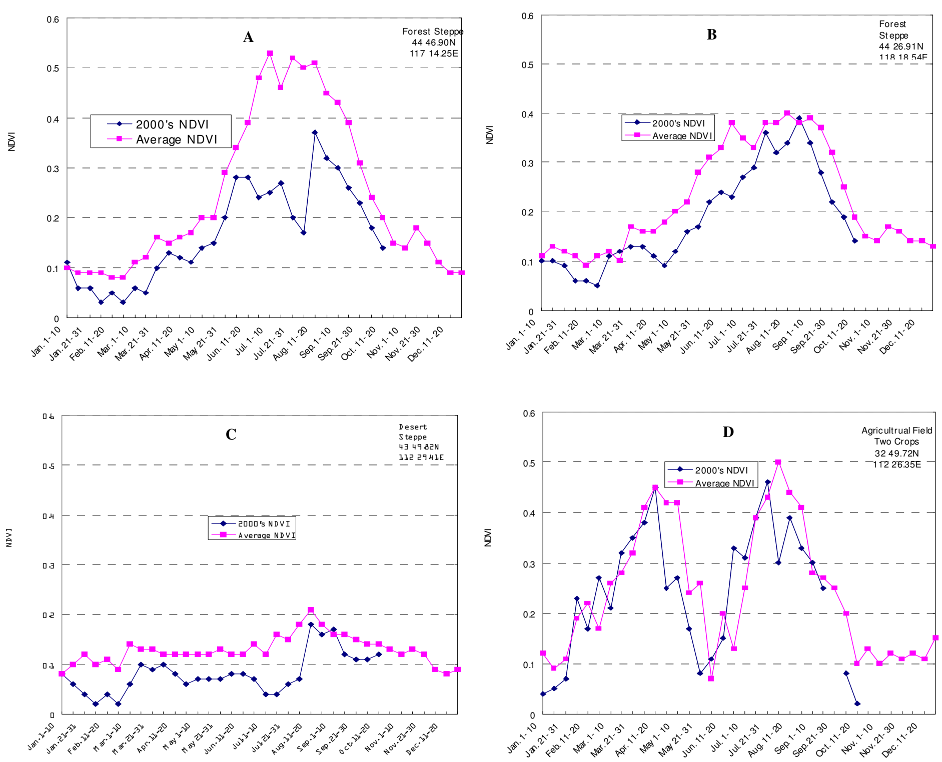

Fig. 5 NDVI profiles of 2000 year and average between 1997, 1998 and 1999.

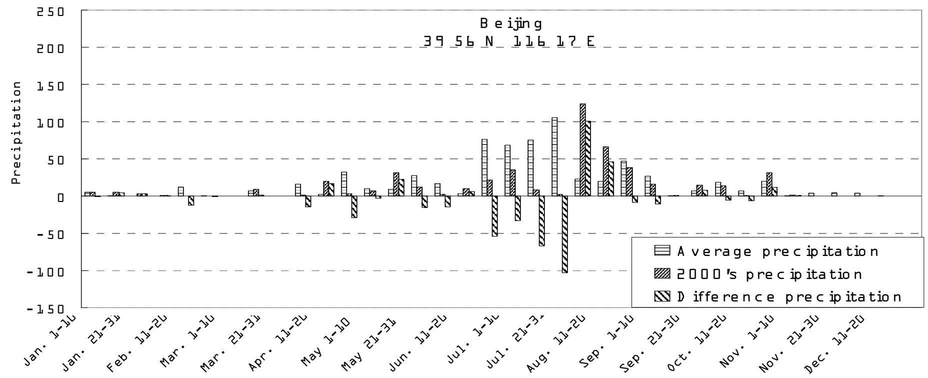

Fig. 6 The standard, 2000 year and difference precipitation at Beijing

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