Time Series Analysis of SPOT VEGETATION Instrument Data for Identifying Agricultural Pattern of Irrigated and Non-irrigated Rice cultivation in Suphanburi Province, Thailand (Draft)

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Abstract: In this paper, we present the different characteristics of NDVI fluctuation pattern between irrigated and non-irrigated area in Suphanburi province, in Central Thailand. For non-irrigated rice cultivation area, the relationship between NDVI fluctuation and peak of rainfall is strong or high correlation while lower correlation in irrigated area. In this study, the classifier called peak detector was developed to identify area of non-irrigated and irrigated with number of cropping. This classifier was created based on the agriculture practice such as number of crops, time or planting period of each crop and its relationship with the peak of rainfall. The classified result showed good accuracy in identification irrigated and non-irrigated rice cultivation areas.

Keywords: Time series analysis, NDVI Time series, SPOT VEGETATION Instrument data, Agriculture pattern.

1. Introduction

The estimation of crop production for food security planning, near real-time identification on actual agricultural pattern such as irrigated or non-irrigated, number of cultivation in a year is firstly necessary. Remote sensing has been playing an important role for many years for the estimation. The main objective of this study is to use multi-temporal Normalized Difference Vegetation Index (NDVI) and rainfall data for improving the estimation of actual irrigated area in global scale. Firstly, this study started to focus on multi-temporal NDVI of irrigated and non-irrigated crops at local scale. Rice, the most important cereal crop in Asia, has been focused and analyzed as a pilot crop. Suphanburi province in Thailand is suitable to be the pilot area because the dominant of agriculture activities in this area is rice cultivation with and without irrigation system.

2. Data and Analysis steps

The SPOT 4, currently in operation, is orbiting the earth at an altitude of 832 km, in a 26-day cycle. The SPOT 4 loads two kinds of sensors: Haute Resolution Visible Infra-Red (HRVIR) instrument and VEGETATION instrument, allowing the daily observation of 2,250 km in swath width with a resolution of 1.15 km for almost all the area, excluding some parts around the equator. While the VEGETATION instrument covers almost all of the earth everyday, therefore it's possible to receive data on cloud free day [4].

In this study 10-day composite of NDVI data observed from January 1999 to December 2001 were analyzed. Local Maximum Fitting (LMF) was executed for the correction of 10-day composite data in order to pursuit cloudless data while space resolution was retained. The LMF processing combines the time series filtering and the functional fitting technique, removes the effect of clouds, hazes and other atmospheric effects from NDVI time series data of each pixel and extracts the seasonal change pattern of the ground [3].

The areas of irrigated and non-irrigated rice were defined based on Landsat TM (08 Jan 2002) and rechecked in the field for setting some certain visited sites. The analysis steps is shown in Figure 1

Fig. 1. Analysis steps

Crop calendar and NDVI fluctuation curve are used as reference to set the visiting time to the observed sites. In this area, dry season cropping starts in February-March. The calendar shown in Table 1 is the most common and corresponds to the "official" period of water distribution by RID (Royal Irrigation Department). Areas located at the tail end of the network will generally get water as late as the end of March, which may preclude farmers from planting dry season rice [2].

Table 1. The most common and "official" period of water distribution by RID

Zone description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eastern Canals (Mae Klong/northern tricts)				←	- - - - -	- - - - -	→	←	- - - - -	- - - - -	→	

Field surveys have been conducted many times to the defined sites at different cropping season and stages of growth. Moreover ground truth data was used for accuracy checking in classified image. In case if the result has low accuracy or not acceptable, the criteria is adjusted or revised until it satisfy the accuracy of classified image.

3. NDVI Time series analysis and Agricultural practice

NDVI time series over 3 years (1999-2001) was analyzed continuously. The fluctuation of NDVI value of irrigated and non-irrigated area were defined based on the field survey. The fluctuation pattern was compared and discussed with rainfall, which has its peak at the beginning of September and also with agricultural pattern. The fluctuation pattern of irrigated and non-irrigated rice cultivation can be summarized in 3.1 and 3.2.

3.1) Non-irrigated Rice

Non-irrigated rice is planted only one time a year, starting around the middle to the end of August till the end of December to the middle of January. After harvested in January, farmers always leave their field blank or change to pasture and will cultivate rice again in the next August (see Figure 2).

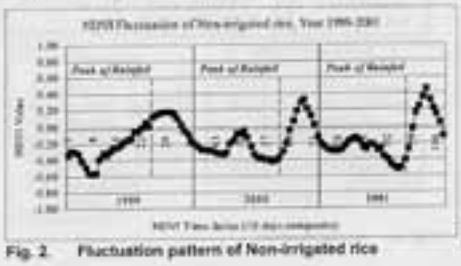

Fig. 2. Fluctuation pattern of Non-irrigated rice

3.2) Irrigated Rice

The observed sites of irrigated rice in this study have different planting patterns including with number of crops planting per year (2-3 crops per year) and cultivation pattern (homogeneous or heterogeneous of rice field). For the large homogeneous field of rice cultivation that have 2 plants in a year, the second half-year crop always has lower density comparing to the planting in the first half of year (see Figure 3).

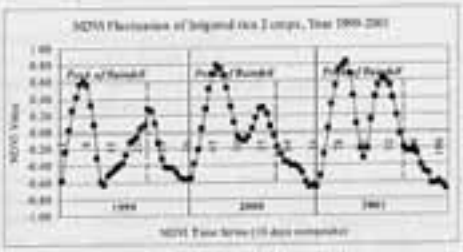

Fig. 3. Fluctuation pattern of irrigated rice 2 crops/year

Figure 4 shows irrigated rice cultivation with 3 times per year in northern Suphanburi. With a good irrigation system in this area, farmers can continue planting 3 times per year.

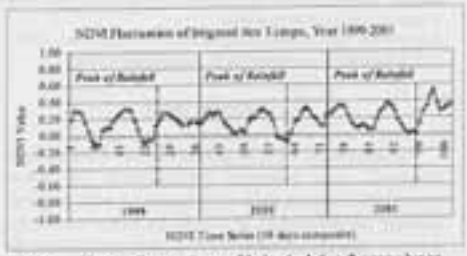

Fig. 4. Fluctuation pattern of irrigated rice 3 crops/year

Figure 5 shows NDVI fluctuation pattern of irrigated rice cultivation 2.5 crop per year or 5 crops in two year.

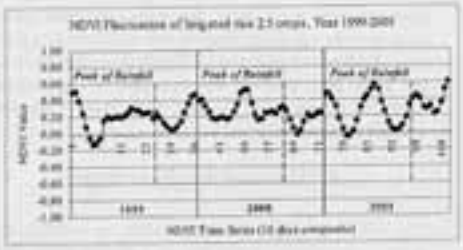

Fig. 5. Fluctuation pattern of irrigated rice 2.5 crops/year

The result of NDVI fluctuation showed clear difference between irrigated and non-irrigated area.

In non-irrigated area, the fluctuation pattern is rather same throughout the study area. The pattern agrees with actual condition on the ground, such as one high peak by cultivation and another low peak that indicate grass growth after harvesting. The NDVI fluctuation pattern in irrigated area varies place to place which was caused by the influence of the unit size of cultivation (large continuous or patchy field) and water distribution from irrigation system. Homogeneous cultivation area shows a few big peaks. Fluctuation pattern in patchy fields shows several low peaks, which come from different cultivation calendar at each unit of cultivation.

4. Peak detector algorithm

The pattern of NDVI fluctuation in time series at various type of rice cultivation and its relationship of rainfall above was summarized and developed as a set of criteria for next step of classification. The details of criteria is for the case:

- Peak is the highest value comparing among 9 neighbor values (We should find one peak only for 3 months)
- Peak value must be higher than 0.2
- If there are 2 or more peaks per year, it is irrigated rice.
- If there is only a peak per year and appears within 50-60 days after peak of rainfall (Beginning of September), it is non-irrigated rice

This criterion was developed and assigned to IDL (the Interactive Data Language) for mapping actual irrigated area or non-irrigated area of rice cultivation in the study area. Before classification process, only area of rice cultivation was firstly extracted by using Landuse map (GIS coverage, 2000) from Office of Agricultural Economics (OAE).

5. Results and Discussion

In this paper, we present 3 years data that was classified into two classes: irrigated and non-irrigated area of rice cultivation by using peak detector algorithm. The verification was done in 2 methods. First, the verification was done using ground truth data and the accuracy of classified result was higher than 90%. Second, we overlaid vector data of irrigated zone in Suphanburi onto the classified results and the result was visually verified.

Figure 6 shows results of classification year by year (1999, 2000 and 2001) that was overlaid with vector data of irrigation zone in Suphanburi. After visually verifying, the overlaid vector covers quite exactly on the class of irrigated area. On the other hand, another class of non-irrigated rice are clearly located outside the vector of irrigation zone.

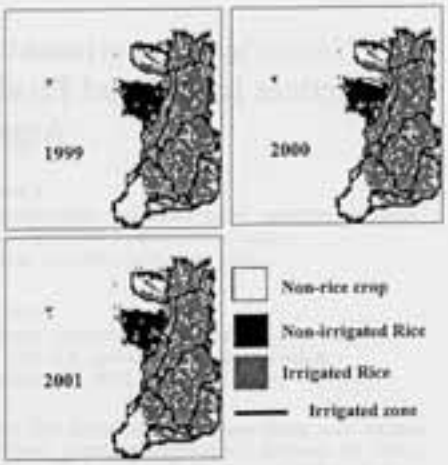

Fig. 6. Results of irrigated area mapping

The classified results show high accuracy, however the algorithm for identifying irrigated and non-irrigated rice areas should be tested in other and/or larger rice areas. Recently, we are trying to develop peak detector algorithm to identify different practice of irrigated rice cultivation in the study area. In future study, the agriculture pattern of others crops will also be observed. Finally the reliable model, which relies on more general parameters (NDVI and Rainfall), is expected to result in irrigated area mapping in global scale.

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