A Comparison of Vegetation Indices for Corn and Soybean Vegetation Condition Monitoring

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1. INTRODUCTION

Crop condition information is critical to decision making in many public and private sectors that concern agricultural production, food security, and food prices. Crop conditions change quickly. Therefore, the continuous crop condition monitoring with a full geospatial coverage and sufficient granularity throughout the season is necessary. The National Agriculture Statistics Services (NASS) of the United States Department of Agricultural (USDA) currently uses a bi-weekly AVHRR normalized difference vegetation index (NDVI) composite provided by the National Oceanic and Atmospheric Administration (NOAA). The AVHRR NDVI maps have been proven valuable in providing a spatially complete view of crop's vegetation condition. It is especially helpful to manifest some major events in US crop production such as massive flood, drought and long last dry cold winter, which resulted in drops in corn and soybean acreages and in yields. These large area views of such events are very informative to policy makers as they provide a complete spatial view, which is virtually impossible to obtain with ground survey data. However, the relatively low spatial resolution of AVHRR NDVI: 1km (about 250 acres) cannot routinely provide crop specific information because of varying crops in the same region, field size limitations, and alternating crop and fallow field patterns. Therefore, the 250m resolution NASA MODIS data, which has better spatial resolution, is proposed to replace the AVHRR NDVI.

In addition, it is well known that the NDVI is sensitive for low vegetation area and saturates for the high vegetation. This characteristic makes it difficult for the early stage or late season crop development detection, which is very important for estimating the crop yield. Therefore, it is necessary to explore a better alternative for crop vegetation condition monitoring.

This paper concerns the alternative vegetation indices for crop vegetation condition measurement. The objective of this study is to empirically evaluate several selected alternate vegetation indices for crop vegetation condition monitoring and to find a better alternate vegetation index, which is less sensitive to the bare soil in low vegetation area and more sensitive in the higher vegetation area (non-saturation).

2. BACKGROUND

In the past decades, there are many vegetation indices are introduced in the remote sensing literature to measure the vegetation cover in different applications [1]. Jordan first presented the simple ratio vegetation index (SR) in 1969 [2]. Rouse et al. [3] further suggested the most widely used Normalized Difference Vegetation Index (NDVI) to improve identifying the vegetated areas and their "condition" in1973. The NDVI, however, is sensitive to bare soil at low vegetation area. To compensate the soil effect, Huete [4] in 1988 proposed a Soil-Adjusted Vegetation Index (SAVI) by introducing a correction factor *L*. But it still saturates at higher vegetation area. Moreover, the correction factor L is ground condition based and is very difficult to determine at an automatic, large-scale operation. Therefore, it was excluded in this study. Bannari *et al*. [5] presented a new vegetation index, transformed difference vegetation index (TDVI). This index shows the same sensitivity as the soil adjusted vegetation index (SAVI) to the optical proprieties of bare soil subjacent to the cover. But it does not saturate like NDVI and SAVI and it shows an excellent linearity as a function of the rate of vegetation cover. This semi-empirical model based vegetation index is less sensitive to soil optical properties variation, and more suitable for estimating the fraction of vegetation cover in forest and agricultural environment. Turner *et al*. [6] indicated that under conditions of low LAI,

where is ρ_R relatively high and ρ_{NIR} relatively low, a small change in produces a larger proportional change in NDVI than SR. With higher LAI, in general, where is ρ_{NIR} higher and ρ_R lower, a small change in ρ_R will introduce a larger proportional change in SR than NDVI. Obviously, the NDVI is sensitive in the lower vegetation area while the SR is relatively sensitive in the higher vegetation area. To balance the balance the sensitivity of both vegetation indices, Gong *et al*. proposed a new combined vegetation index RNDVI, which was composed by taking the product of NDVI and SR [7]. They reported that it has slightly better correlation with the LAI than its original indices. However, conceptually, RNDVI is sort of second order vegetation index, which by definition will enhance higher vegetation (higher index value) area and suppress the lower vegetation (lower index value) area. To alleviate this effect, we present a new vegetation index GRNDVI, which takes geometric average of NDVI and SR based on the merits of RNDVI.

3. EXPERIMENTAL DATA AND METHOD

The data used for experiment is L2G MODIS product MOD09GQ. It is Bands 1–2 daily, Surface Reflectance with 250m resolution on MODIS terra platform. Bands 1-2 are red and IR bands. The data time series is from May 10, 2007 to October 28, 2007. The study area covers major corn and soybean state Iowa. There are 24 evenly distributed areas of interest (AOI) selected for test. The AOI for evaluation are segmented by corn and soybean crops and geo location based on the information from NASS Cropland Data Layer (CDL), which provides the detailed crop distribution spatially. The time series data is preprocessed to eliminate the cloudy and haze before vegetation calculation. The data was then filtered and interpolated with quadratic polynomial. In the study, there were 5 vegetation indices (including SR, NDVI, TDVI, RNDVI and GRNDVI) were computed and normalized based on the processed data. The normalized vegetation indices were plotted for comparison.

4. CONCLUSION

In this paper, a new vegetation index is presented for potential crop vegetation condition monitoring. The preliminary study shows that the composed vegetation indices RNDVI and GRNDVI are more sensitive to vegetation cover in both lower and higher vegetation areas than SR, NDVI and TDVI indices. Therefore, they both perform better for subtle vegetation change in both lower and higher vegetation area. Moreover, the vegetation index GRNDVI proposed in this paper is less sensitive to than RNDVI and will over emphasize the high vegetation. It is found that the behavior of TDVI is similar to that of NDVI. Moreover, it is also found that the vegetation conditions vary significantly with different geo locations when measured with RNDVI and GRNDVI.

5. REFERENCES

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