remote sensing

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Editorial

Preface: Recent Advances in Remote Sensing for Crop Growth Monitoring

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Abstract: This Special Issue gathers sixteen papers focusing on applying various remote sensing techniques to crop growth monitoring. The studies span observations from multiple scales, a combination of model simulations and experimental measurements, and a range of topics on crop monitoring and mapping. This preface provides a brief overview of the contributed papers.

Keywords: crop status; crop monitoring; crop mapping; canopy reflectance; spectral; optical; SAR; phenology

1. Scope

Crop growth can be monitored with remotely sensed data acquired at various platforms in support of precision management of crop production. While a large variety of studies focus on the crop growth parameters such as leaf nitrogen content and leaf area index, the community also shows great interests in continuously monitoring crop spectral properties and large scale mapping of crop types and crop acreage. New analytical methods, instruments and applications for more accurate, reliable and efficient monitoring of crop conditions are continually reported and published in the literature.

Crop growth cycles often vary with different crop types. High temporal and spatial resolution remotely sensed data enable continuous crop growth monitoring for entire growth cycles in the context of spatially explicit mapping. It has promoted many research interests on the use of remotely sensed data to monitor all major growth stages and on the development of novel algorithms for processing such a big volume of data.

The availability of free imagery data from an ever increasing number of Earth Observation missions enables us to use observations acquired from multiple dates during the growing season. At the ground level, continuous monitoring of crop status is also made possible by using proximal sensor networks deployed in various crop fields. There have been numerous studies on using the crop phenological information for crop monitoring, including the direct use of multi-temporal data to extract phenological metrics from time series data.

The majority of crop monitoring studies use surface reflectance data acquired from optical instruments. However, crop monitoring may be adversely affected by weather conditions such as cloud cover and rainfall. This is particularly the case for major rice growing regions in China and southeastern Asian countries. Researchers have been working on integrating optical data with Synthetic Aperture Radar (SAR) data to avoid missing the observations at critical growth stages, which exploits backscatter information pertinent to crop biophysical properties.

This Special Issue was initiated at the International Symposium on Crop Growth Monitoring (ISCGM) held in Nanjing, China from September 13-16, 2014. It covers a selection of work reporting on recent advances in crop growth monitoring based on remotely sensed data. The Special Issue covers papers in crop status assessment and monitoring, and crop mapping. The following section summarizes the content of the selected papers.

2. Overview of Contributions

The papers selected cover remote sensing observations at leaf, canopy, field and farm scales and span a number of application fields such as crop parameters estimation, crop status assessment, and crop dynamics monitoring. Zhao *et al.* [1] showcase their attempt at inverting crop leaf fluorescence parameters from the leaf-level fluorescence model, FluorMODleaf. As a simpler and more straightforward approach, spectral indices have received more attention in this Special Issue. Yao *et al.* [2] provided a comprehensive evaluation of six empirical methods (e.g., spectral indices, continuum removal, partial least squares regression) for estimating the leaf nitrogen concentration of wheat crops from canopy reflectance spectra. The development of a new spectral index for quantifying leaf area index (LAI) of winter wheat is demonstrated by Tanaka *et al.* [3]. The use of spectral indices for nitrogen status monitoring and diagnosis of rice crops at field scale is illustrated by Huang *et al.* [4] with FORMOSAT-2 satellite imagery. With more frequent samplings, spectral indices can be used to optimize the estimation of fruit yield and quality [5] and to improve the assessment of crop temporal dynamics [6]. Spectral indices are also employed by Guo *et al.* [7] for characterizing canopy structure and light radiation at different depths within the canopy for rice crops. Given the variation in illumination intensity and geometry for continuous spectral measurements, Ishihara *et al.* [8] investigate the impact of sunlight conditions on the consistency of two greenness indices over the growing season for crop monitoring with spectral observations from a ground-based sensor network.

At a regional level, a number of papers report on crop type classification and crop acreage mapping with medium (e.g., Landsat and HJ-1 A/B) and low resolution (e.g., MODIS) satellite imagery. None of the classification and mapping efforts in this Special Issue use the spectral information from optical satellite data alone. Instead, these studies demonstrate that it is advantageous to integrate spectral information either with temporal information from time series optical images or with backscatter information from SAR data. With multi-temporal optical data, the rice planting areas are mapped for the Yangtze River Delta region [9] and the eastern plain region of China [10], respectively. Particularly, the crop phenological information extracted from time series data is used for multi-sensor crop mapping [11] and fractional crop mapping [12]. In addition, Hao *et al.* [13] investigate the effect of temporal extent in time series data on crop mapping. With the integration of optical and SAR data, Villa *et al.* [14] develop a classification tree approach for in-season mapping of crop types, and Boschetti *et al.* [15] demonstrate an approach to provide pre-event and in-season information on the status of crops in a disaster response. Apart from crop growth conditions, the environmental conditions in agricultural regions should also be assessed with remote sensing techniques, as examined for air temperature mapping by Huang *et al.* [16].

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