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Remote Sensing of Leaf Area Index (LAI) and Other Vegetation Parameters

Edited by
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About the Special Issue Editors

Francisco Javier García-Haro obtained his PhD (1997) in quantitative remote sensing from the University of Valencia. He is currently a Professor in the Department of Earth Physics and Thermodynamics, University of Valencia. His main research interests lie in canopy radiative transfer modeling and retrieval vegetation properties using satellite, including applications such as agro-meteorology, land and soil resources, agriculture, and forestry. He is responsible for the design and scientific validation of LSA SAF vegetation products from EUMETSAT satellites (https://landsaf.ipma.pt). His scientific production includes 60 papers, over 200 conference proceedings, and numerous technical reports. He is involved in several validation networks and exploitation programs of satellite missions and has received several research awards.

Hongliang Fang obtained his PhD (2003) in quantitative remote sensing from the Department of Geographical Sciences, University of Maryland, College Park. He is now a Professor in the Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences (CAS). His main research interests lie in land surface biophysical parameter estimation, radiative transfer modeling, calibration and validation studies, and in situ measurements. He is an associate editor of the IEEE Geoscience and Remote Sensing Letters and Acta Geographica Sinica. He now serves as the leaf area index (LAI) focus area lead of the CEOS/WGCV/LPV. He is a senior member of IEEE and a member of AGU. (http://sourcedb.igsnrr.cas.cn/yw/zjrck/200910/t20091028_2638835.html).

Juanma Lopez Sanchez obtained his PhD (2000) in electrical engineering from the Technical University of Valencia (UPV). He is currently a Full Professor in the Department of Physics, System Engineering and Signal Theory, University of Alicante. His main research interests lie in radar remote sensing technology and applications, with special attention to SAR interferometry and polarimetry for geophysics and agriculture. He is the leader of the SST research group at the University of Alicante since 2003. His scientific production includes 70 papers, over 110 conference proceedings, and numerous technical reports. He is a senior member of IEEE.

Preface to "Remote Sensing of Leaf Area Index (LAI) and Other Vegetation Parameters"

The monitoring of vegetation structure and functioning is critical to the modeling of terrestrial ecosystems and energy cycles. In particular, leaf area index (LAI) is an important structural property of vegetation used in many land surface vegetation, climate, and crop production models. Canopy structure (LAI, fCover, plant height, and biomass) and biochemical parameters directly influence the radiative transfer process of sunlight in vegetation, determining the amount of radiation measured by passive sensors in the visible and infrared portions of the electromagnetic spectrum.

Optical remote sensing methods build relationships exploiting in situ measurements and/or as outputs of physical canopy radiative transfer models. The increased availability of passive (radar and LiDAR) remote sensing data has fostered their use in many applications for the analysis of land surface properties and processes, thanks also to their insensitivity to weather conditions and the capability to exploit rich structural and texture information. Data fusion and multi-sensor integration techniques are pressing topics to fully exploit the information conveyed by both optical and microwave bands.

This Special Issue reviews the state-of-the-art in the retrieval of LAI, biomass, and other vegetation parameters using field, satellite, and airborne data, assimilation of remote sensing data with vegetation models, and its usage in wide variety of forest applications. It is composed of the following six sections:

- Field methods to measure LAI and other vegetation parameters

This section brings together innovative methods to measure LAI and other vegetation parameters. The section is composed of four chapters. The first chapter presents a smartphone-based method to measure conifer forest LAI. The second chapter presents a practical procedure to estimate the over and understory vegetation cover in Mexican forests using digital photography. The third chapter demonstrates the applicability of GPS and hemispheric photography-based methods to determine a forest signal absorption coefficient index. The final chapter in this section deals with the estimation of forest LAI and biomass patterns across Northeast China from digital aerial photograph data.

Potential and Limits of Retrieving Conifer Leaf Area Index Using Smartphone-Based Methods
Estimation of Vegetation Cover Using Digital Photography in a Regional Survey of Central Mexico
Development of a GPS Forest Signal Absorption Coefficient Index
Estimation of Forest Aboveground Biomass and Leaf Area Index Based on Digital Aerial Photograph Data in Northeast China

- Estimation of forest aboveground biomass (AGB)

The three chapters of this section are devoted to estimates of forest AGB using different data and methods. The first chapter deals with the use RapidEye optical data at the national level over Tanzania. The second chapter demonstrates the use of optical (Landsat, MODIS) and radar (ALOS-1 PALSAR, Sentinel-1) for mapping the AGB of a degraded Amazonian forest at the regional scale. The third chapter presents an approach for the estimation of forest vertical profiles and AGB using SAR (P-Band PolInSAR) images.

The Potential of High Resolution (5 m) RapidEye Optical Data to Estimate Aboveground Biomass at the National Level over Tanzania The Potential of Multisource Remote Sensing for Mapping the Biomass of a Degraded Amazonian Forest Forest Aboveground Biomass Estimation Using Single-Baseline Polarization Coherence Tomography with P-Band PolInSAR Data

- Unmanned aerial vehicle (UAV) sensors

This section is composed of three chapters. The first chapter evaluates UAV point cloud for estimating forest biophysical properties in managed temperate coniferous forests. The second chapter deals with individual tree detection from a UAV-derived canopy height model. The final chapter in this section presents an approach for the estimation of tree parameters using spectral correlation between UAV and Pléiades data.

Forest Structure Estimation from a UAV-Based Photogrammetric Point Cloud in Managed Temperate Coniferous Forests Individual Tree Detection from Unmanned Aerial Vehicle (UAV)-Derived Canopy Height Model in an Open Canopy Mixed Conifer Forest Estimation and Extrapolation of Tree Parameters Using Spectral Correlation between UAV and Pléiades Data

- LiDAR remote sensing

This section addresses new insights in the development, application, and benefits of terrestrial laser-scanning methods. The section is composed of three chapters. The first chapter addresses the automatic mapping of mapping of tree positions and tree diameter based on LiDAR and HP. The second chapter deals with the mapping of forest stands based on three-dimensional point clouds derived from terrestrial laser-scanning. The third chapter deals with the estimation of forest LAI and biomass patterns across Northeast China based on allometric scale relationship with large footprint LiDAR waveform data.

Effects of Tree Trunks on Estimation of Clumping Index and LAI from HemiView and Terrestrial LiDAR Automatic Mapping of Forest Stands Based on Three-Dimensional Point Clouds Derived from Terrestrial Laser-Scanning Estimation of Forest Biomass Patterns across Northeast China Based on Allometric Scale Relationship

- Validation of LAI products

This section addresses recent advances in the validation of LAI products. The first chapter evaluates the uncertainty and spatiotemporal consistency of global LAI and FPAR Products from VIIRS and MODIS Sensors. The second chapter calculates and validates LAI estimates generated from the USDA model in the Southeastern USA.

Analysis of Global LAI/FPAR Products from VIIRS and MODIS Sensors for Spatiotemporal Consistency and Uncertainty from 2012 to 2016 A Comparison of Simulated and Field-Derived Leaf Area Index (LAI) and Canopy Height Values from Four Forest Complexes in the Southeastern USA

- Forest applications

The last section includes a variety of forest applications for mapping and monitoring of forest disturbance, degradation, and regrowth using remotely sensed imagery. The first chapter assesses the extent of the forest cover and deforestation rates in the tropical forests in Paraguay over 17 years. The second chapter addresses the use of phenological metrics from MODIS data to monitor phenological phases and altitudinal variations in European beech-dominated stands. The last chapter in this section assesses the response of the photosynthetic activity of Mediterranean evergreen oaks using remote sensing physiological indices.

Assessing Forest Cover Dynamics and Forest Perception in the Atlantic Forest of Paraguay, Combining Remote Sensing and Household-Level Data Validation and Application of European Beech Phenological Metrics Derived from MODIS Data along an Altitudinal Gradient Assessment of the Response of Photosynthetic Activity of Mediterranean Evergreen Oaks to Enhanced Drought Stress and Recovery by Using PRI and R690/R630

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