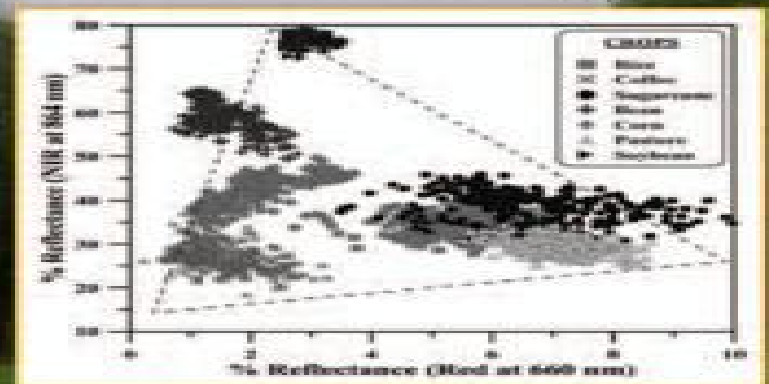
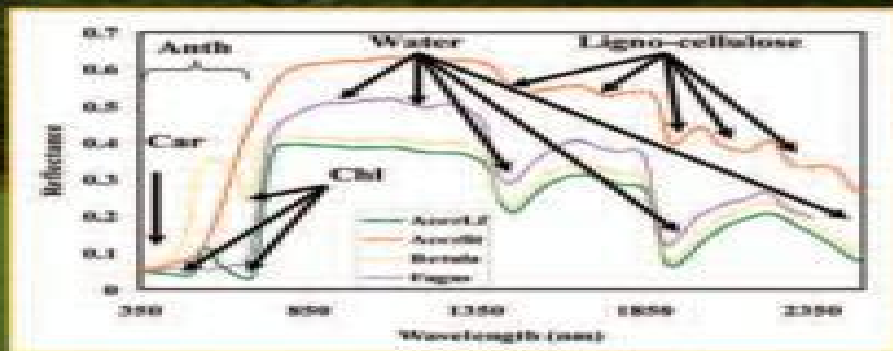


# HYPERSENSPECTRAL REMOTE SENSING OF VEGETATION



*Edited by*

Prasad S. Thenkabail  
John G. Lyon  
Alfredo Huete

# Hyperspectral Remote Sensing Of Vegetation

**Prasad S. Thenkabail, John G.  
Lyon, Alfredo Huete**



## **Hyperspectral Remote Sensing Of Vegetation:**

*Hyperspectral Remote Sensing of Vegetation* Prasad S. Thenkabail, John G. Lyon, 2016-04-19 Hyperspectral narrow band or imaging spectroscopy spectral data are fast emerging as practical solutions in modeling and mapping vegetation. Recent research has demonstrated the advances in and merit of hyperspectral data in a range of applications including quantifying agricultural crops, modeling forest canopy biochemical properties, detecting crop stress and disease, mapping leaf chlorophyll content as it influences crop production, identifying plants affected by contaminants such as arsenic, demonstrating sensitivity to plant nitrogen content, classifying vegetation species and type, characterizing wetlands, and mapping invasive species. The need for significant improvements in quantifying modeling and mapping plant chemical, physical, and water properties is more critical than ever before to reduce uncertainties in our understanding of the Earth and to better sustain it. There is also a need for a synthesis of the vast knowledge spread throughout the literature from more than 40 years of research.

*Hyperspectral Remote Sensing of Vegetation* integrates this knowledge, guiding readers to harness the capabilities of the most recent advances in applying hyperspectral remote sensing technology to the study of terrestrial vegetation. Taking a practical approach to a complex subject, the book demonstrates the experience, utility, methods, and models used in studying vegetation using hyperspectral data. Written by leading experts, including pioneers in the field, each chapter presents specific applications, reviews existing state-of-the-art knowledge, highlights the advances made, and provides guidance for the appropriate use of hyperspectral data in the study of vegetation, as well as its numerous applications, such as crop yield modeling, crop and vegetation biophysical and biochemical property characterization, and crop moisture assessment. This comprehensive book brings together the best global expertise on hyperspectral remote sensing of agriculture, crop water use, plant species detection, vegetation classification, biophysical and biochemical modeling, crop productivity, and water productivity mapping and modeling. It provides the pertinent facts, synthesizing findings so that readers can get the correct picture on issues such as the best wavebands for their practical applications, methods of analysis using whole spectra, hyperspectral vegetation indices targeted to study specific biophysical and biochemical quantities, and methods for detecting parameters such as crop moisture variability, chlorophyll content, and stress levels. A collective knowledge bank, it guides professionals to adopt the best practices for their own work.

***Hyperspectral Remote Sensing of Vegetation, Second Edition, Four Volume Set*** Prasad S. Thenkabail, John G. Lyon, Alfredo Huete, 2022-07-30 Written by leading global experts, including pioneers in the field, the four volume set on *Hyperspectral Remote Sensing of Vegetation, Second Edition* reviews existing state-of-the-art knowledge, highlights advances made in different areas, and provides guidance for the appropriate use of hyperspectral data in the study and management of agricultural crops and natural vegetation. Volume I: Fundamentals, Sensor Systems, Spectral Libraries, and Data Mining for Vegetation introduces the fundamentals of hyperspectral or imaging spectroscopy data, including hyperspectral data processes, sensor systems, spectral libraries, and data mining and analysis.

covering both the strengths and limitations of these topics Volume II Hyperspectral Indices and Image Classifications for Agriculture and Vegetation evaluates the performance of hyperspectral narrowband or imaging spectroscopy data with specific emphasis on the uses and applications of hyperspectral narrowband vegetation indices in characterizing modeling mapping and monitoring agricultural crops and vegetation Volume III Biophysical and Biochemical Characterization and Plant Species Studies demonstrates the methods that are developed and used to study terrestrial vegetation using hyperspectral data This volume includes extensive discussions on hyperspectral data processing and how to implement data processing mechanisms for specific biophysical and biochemical applications such as crop yield modeling crop biophysical and biochemical property characterization and crop moisture assessments Volume IV Advanced Applications in Remote Sensing of Agricultural Crops and Natural Vegetation discusses the use of hyperspectral or imaging spectroscopy data in numerous specific and advanced applications such as forest management precision farming managing invasive species and local to global land cover change detection

*Hyperspectral Remote Sensing of Agriculture and Vegetation* Simone Pascucci, Stefano Pignatti, Raffaele Casa, Roshanak Darvishzadeh, Wenjiang Huang, 2021-01-20 This book shows recent and innovative applications of the use of hyperspectral technology for optimal quantification of crop vegetation and soil biophysical variables at various spatial scales which can be an important aspect in agricultural management practices and monitoring The articles collected inside the book are intended to help researchers and farmers involved in precision agriculture techniques and practices as well as in plant nutrient prediction to a higher comprehension of strengths and limitations of the application of hyperspectral imaging to agriculture and vegetation Hyperspectral remote sensing for studying agriculture and natural vegetation is a challenging research topic that will remain of great interest for different sciences communities in decades

**Hyperspectral Remote Sensing of Vegetation Parameters Using Statistical and Physical Models** Roshanak Darvishzadeh, 2008

*Hyperspectral Remote Sensing* Ruiliang Pu, 2017-08-16 Advanced imaging spectral technology and hyperspectral analysis techniques for multiple applications are the key features of the book This book will present in one volume complete solutions from concepts fundamentals and methods of acquisition of hyperspectral data to analyses and applications of the data in a very coherent manner It will help readers to fully understand basic theories of HRS how to utilize various field spectrometers and bioinstruments the importance of radiometric correction and atmospheric correction the use of analysis tools and software and determine what to do with HRS technology and data

*Advanced Applications in Remote Sensing of Agricultural Crops and Natural Vegetation* Prasad S. Thenkabail, John G. Lyon, Alfredo Huete, 2018-12-07 Written by leading global experts including pioneers in the field the four volume set on Hyperspectral Remote Sensing of Vegetation Second Edition reviews existing state of the art knowledge highlights advances made in different areas and provides guidance for the appropriate use of hyperspectral data in the study and management of agricultural crops and natural vegetation Volume IV Advanced Applications in Remote Sensing of Agricultural Crops and

Natural Vegetation discusses the use of hyperspectral or imaging spectroscopy data in numerous specific and advanced applications such as forest management precision farming managing invasive species and local to global land cover change detection It emphasizes the importance of hyperspectral remote sensing tools for studying vegetation processes and functions as well as the appropriate use of hyperspectral data for vegetation management practices The concluding chapter provides readers with useful guidance on the highlights and essence of Volume IV through the editors perspective Key Features of Volume IV Guides readers to harness the capabilities of the most recent advances in applying hyperspectral remote sensing technology to the study of terrestrial vegetation Includes specific applications on agriculture crop management practices study of crop stress and diseases crop characteristics based on inputs e g nitrogen irrigation study of vegetation impacted by heavy metals gross and net primary productivity studies light use efficiency studies crop water use and actual evapotranspiration studies phenology monitoring land use and land cover studies global change studies plant species detection wetland and forest characterization and mapping crop productivity and crop water productivity mapping and modeling Encompasses hyperspectral or imaging spectroscopy data in narrow wavebands used across visible red edge near infrared far infrared shortwave infrared and thermal portions of the spectrum Explains the implementation of hyperspectral remote sensing data processing mechanisms in a standard fast and efficient manner for their applications Discusses cloud computing to overcome hyperspectral remote sensing massive big data challenges Provides hyperspectral analysis of rocky surfaces on the earth and other planetary systems

**Hyperspectral Indices and Image Classifications for Agriculture and Vegetation** Prasad S. Thenkabail, John G. Lyon, Alfredo Huete, 2018-12-06 Evaluating the performance of various types of hyperspectral vegetation indices in characterizing agricultural crops this volume discusses non invasive quantification of foliar pigments leaf nitrogen concentration of cereal crop the estimation of nitrogen content in crops and pastures forest leaf chlorophyll content among others Each chapter reviews existing state of art knowledge highlights the advances made and provides guidance for appropriate use of hyperspectral images in study of vegetation The concluding chapter provides readers with the editor s view and guidance on the highlights and the essence of the Volume 2 and the editor s perspective

Hyperspectral Remote Sensing of Vegetation: Hyperspectral indices and image classifications for agriculture and vegetation Prasad Srinivasa Thenkabail, John G. Lyon, Alfredo Huete, 2019

Hyperspectral Remote Sensing of Vegetation: Advanced applications in remote sensing of agricultural crops and natural vegetation Prasad Srinivasa Thenkabail, John G. Lyon, Alfredo Huete, 2019

*Fundamentals, Sensor Systems, Spectral Libraries, and Data Mining for Vegetation* Prasad S. Thenkabail, John G. Lyon, Alfredo Huete, 2018-12-07 Written by leading global experts including pioneers in the field the four volume set on Hyperspectral Remote Sensing of Vegetation Second Edition reviews existing state of the art knowledge highlights advances made in different areas and provides guidance for the appropriate use of hyperspectral data in the study and management of agricultural crops and natural vegetation Volume I Fundamentals Sensor Systems

Spectral Libraries and Data Mining for Vegetation introduces the fundamentals of hyperspectral or imaging spectroscopy data including hyperspectral data processes sensor systems spectral libraries and data mining and analysis covering both the strengths and limitations of these topics This book also presents and discusses hyperspectral narrowband data acquired in numerous unique spectral bands in the entire length of the spectrum from various ground based airborne and spaceborne platforms The concluding chapter provides readers with useful guidance on the highlights and essence of Volume I through the editors perspective Key Features of Volume I Provides the fundamentals of hyperspectral remote sensing used in agricultural crops and vegetation studies Discusses the latest advances in hyperspectral remote sensing of ecosystems and croplands Develops online hyperspectral libraries proximal sensing and phenotyping for understanding modeling mapping and monitoring crop and vegetation traits Implements reflectance spectroscopy of soils and vegetation Enumerates hyperspectral data mining and data processing methods approaches and machine learning algorithms Explores methods and approaches for data mining and overcoming data redundancy Highlights the advanced methods for hyperspectral data processing steps by developing or implementing appropriate algorithms and coding the same for processing on a cloud computing platform like the Google Earth Engine Integrates hyperspectral with other data such as the LiDAR data in the study of vegetation Includes best global expertise on hyperspectral remote sensing of agriculture crop water use plant species detection crop productivity and water productivity mapping and modeling

**Hyperspectral Remote Sensing of Agriculture and Vegetation** Simone Pascucci, Stefano Pignatti, Raffaele Casa, Roshanak Darvishzadeh, Wenjiang Huang, 2021 This book shows recent and innovative applications of the use of hyperspectral technology for optimal quantification of crop vegetation and soil biophysical variables at various spatial scales which can be an important aspect in agricultural management practices and monitoring The articles collected inside the book are intended to help researchers and farmers involved in precision agriculture techniques and practices as well as in plant nutrient prediction to a higher comprehension of strengths and limitations of the application of hyperspectral imaging to agriculture and vegetation Hyperspectral remote sensing for studying agriculture and natural vegetation is a challenging research topic that will remain of great interest for different sciences communities in decades

Hyperspectral Remote Sensing of Vegetation: Biophysical and biochemical characterization and plant species studies Prasad Srinivasa Thenkabail, John G. Lyon, Alfredo Huete, 2019

*Hyperspectral Remote Sensing of Vegetation Species Distribution in a Saltmarsh* Karin S. Schmidt, 2003

*Remote Sensing Handbook - Three Volume Set* Prasad Thenkabail, 2018-10-03 A volume in the three volume Remote Sensing Handbook series Remote Sensing of Water Resources Disasters and Urban Studies documents the scientific and methodological advances that have taken place during the last 50 years The other two volumes in the series are Remotely Sensed Data Characterization Classification and Accuracies and Land Reso

Land Resources Monitoring, Modeling, and Mapping with Remote Sensing Ph.D., Prasad S. Thenkabail, 2015-10-02 A volume in the three volume Remote Sensing Handbook series Land Resources

Monitoring Modeling and Mapping with Remote Sensing documents the scientific and methodological advances that have taken place during the last 50 years. The other two volumes in the series are Remotely Sensed Data Characterization Classification and Accuracies and Remote Sensing of Water Resources Disasters and Urban Studies. In true handbook style, the chapters in the volume have been carefully selected, organized and designed to be self-contained so that you can focus on a chapter and read it through without having to be overly dependent on other chapters. This volume provides comprehensive theoretical and practical coverage of remote sensing of land resources that include vegetation and biomass, agricultural croplands, rangelands, phenology and food security, forests, biodiversity, ecology, land use, land cover, carbon and soils. Highlights include Global terrestrial carbon and carbon budgets, Precision farming, Agricultural systems studies and soil studies, Global croplands, agricultural croplands and rangelands, Food security analysis, Biodiversity, Land use and land cover mapping, Measuring photosynthesis from space, Vegetation characterization and above ground biomass measurements and modeling, Hyperspectral remote sensing, Ecological studies, Tropical forest characterization, Habitat mapping and monitoring. In a very practical way, the book demonstrates the experience, utility, methods and models used in studying a wide array of land applications. With more than 100 leading global contributors, this book is the most comprehensive documentation of the scientific and methodological advances that have taken place in understanding remote sensing data methods and applications over last 50 years. In a very practical way, the book demonstrates the experience, utility, methods and models used in studying a wide array of Land applications.

**Hyperspectral Remote Sensing** Prem Chandra Pandey, Prashant K. Srivastava, Heiko Balzter, Bimal Bhattacharya, George P. Petropoulos, 2020-08-05. Hyperspectral Remote Sensing Theory and Applications offers the latest information on the techniques, advances and wide ranging applications of hyperspectral remote sensing such as forestry, agriculture, water resources, soil and geology among others. The book also presents hyperspectral data integration with other sources such as LiDAR, Multi spectral data and other remote sensing techniques. Researchers who use this resource will be able to understand and implement the technology and data in their respective fields. As such, it is a valuable reference for researchers and data analysts in remote sensing and Earth Observation fields and those in ecology, agriculture, hydrology and geology. Includes the theory of hyperspectral remote sensing along with techniques and applications across a variety of disciplines. Presents the processing methods and techniques utilized for hyperspectral remote sensing and in situ data collection. Provides an overview of the state of the art including algorithms, techniques and case studies.

**Biophysical and Biochemical Characterization and Plant Species Studies** Prasad S. Thenkabail, John G. Lyon, Alfredo Huete, 2018-12-06. Hyperspectral remote sensing has been increasingly used in studying and assessing biophysical and biochemical properties of agricultural crops. This volume demonstrates the experience and the methods used in studying terrestrial vegetation using hyperspectral data. It focuses on specific applications, reviews existing state of art knowledge, highlights the advances made and provides guidance for appropriate use of hyperspectral data in applications.

such as crop yield modeling crop biophysical and biochemical property characterization and crop moisture assessment Includes extensive discussions on data processing and how to implement data processing mechanisms Hyperspectral Remote Sensing of Vegetation - a Transect Approach Reza Amiri, 2013 Human induced global environmental changes are increasingly occurring at larger scales Terrestrial vegetation is largely affected by such anthropologic land transformations As a result the ability to monitor the status of terrestrial vegetation is essential for understanding and managing these changes The rich spectral information contained in hyperspectral data provides a promising source of information for earth observation of global change However the analytical methods for the retrieval of vegetation bioindicators from hyperspectral data are suggested to lack spatial transferability This is important because spatial transferability is the underlying assumption in employing these methods at large scales Therefore to apply these analytical approaches confidently study of their spatial transferability is required Thus the aim of this thesis is to assess the robustness of currently dominant empirical methods in the context of a sub continental environmental gradient In the first part of the study the performance of commonly used spectral vegetation indices for the retrieval of leaf biochemical constituents was systematically assessed along a strong rainfall gradient in savannas of northern Australia The results demonstrated that in cross site situations the performance of the estimation of the foliar biochemical properties was dependent on the biochemical constituent For example estimation of leaf nitrogen content was largely consistent at the sampling sites while leaf chlorophyll and carotenoid contents were affected by fluctuations along the gradient Furthermore the study of the performance of the indices in a cross species situation revealed that except for carotenoid content the narrowband predictors were species specific These findings indicate that the observed inconsistency of the vegetation indices at the scale of this study is likely to affect the applications that utilise the prediction of leaf biochemical properties provided by these indices The second part of the study assessed the robustness of partial least square regression PLSR multivariate technique for the retrieval of leaf biochemical properties along the NATT The results showed that PLSR provided more consistent predictions across the sites along the gradient This provided evidence that multivariate methods may be a better alternative in large scale estimations of biochemical constituents Additionally the spatial transferability of the partial least square regression technique was assessed and compared to the vegetation indices It was demonstrated that no method was able to produce solutions transferable to the whole transect The final part of the study incorporated the large scale transferability as an objective in a multiobjective optimisation framework to design transferable hyperspectral predictors of foliar biochemical properties The method introduced improvements in the vegetation indices based estimations by finding an optimal waveband demonstrating both stability and performance in the predictions along the NATT In summary findings from this work contribute to the understanding of the reliability of the currently dominant information retrieval methods from narrowband hyperspectral reflectance data The multiobjective optimisation method implemented in this work is of added benefit by providing a



framework for addressing the issue of transferability

**Remote Sensing Handbook, Volume I** Prasad S.

Thenkabail,2024-11-29 Volume I of the Six Volume Remote Sensing Handbook Second Edition is focused on satellites and sensors including radar light detection and ranging LiDAR microwave hyperspectral unmanned aerial vehicles UAVs and their applications It discusses data normalization and harmonization accuracies and uncertainties of remote sensing products global navigation satellite system GNSS theory and practice crowdsourcing cloud computing environments Google Earth Engine and remote sensing and space law This thoroughly revised and updated volume draws on the expertise of a diverse array of leading international authorities in remote sensing and provides an essential resource for researchers at all levels interested in using remote sensing It integrates discussions of remote sensing principles data methods development applications and scientific and social context FEATURES Provides the most up to date comprehensive coverage of remote sensing science Discusses and analyzes data from old and new generations of satellites and sensors Provides comprehensive methods and approaches for remote sensing data normalization standardization and harmonization Includes numerous case studies on advances and applications at local regional and global scales Introduces advanced methods in remote sensing such as machine learning cloud computing and AI Highlights scientific achievements over the last decade and provides guidance for future developments This volume is an excellent resource for the entire remote sensing and GIS community Academics researchers undergraduate and graduate students as well as practitioners decision makers and policymakers will benefit from the expertise of the professionals featured in this book and their extensive knowledge of new and emerging trends

**Remote Sensing Handbook, Volume II** Prasad S. Thenkabail,2024-11-29 Volume II of the Six Volume Remote Sensing Handbook Second Edition is focused on digital image processing including image classification methods in land cover and land use It discusses object based segmentation and pixel based image processing algorithms change detection techniques and image classification for a wide array of applications including land use land cover croplands urban studies processing hyperspectral remote sensing data thermal imagery light detection and ranging LiDAR geoprocessing workflows frontiers of GIScience and future pathways This thoroughly revised and updated volume draws on the expertise of a diverse array of leading international authorities in remote sensing and provides an essential resource for researchers at all levels interested in using remote sensing It integrates discussions of remote sensing principles data methods development applications and scientific and social context Features Provides the most up to date comprehensive coverage of digital image processing Highlights object based image analysis OBIA and pixel based classification methods and techniques of digital image processing Demonstrates practical examples of image processing for a myriad of applications such as land use land cover croplands and urban Establishes image processing using different types of remote sensing data that includes multispectral radar LiDAR thermal and hyperspectral Highlights change detection geoprocessing and GIScience This volume is an excellent resource for the entire remote sensing and GIS community Academics researchers undergraduate and graduate

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