## PROCEEDINGS OF SPIE

# Remote Sensing for Agriculture, Ecosystems, and Hydrology XIX

Christopher M. U. Neale Antonino Maltese Editors

12–15 September 2017 Warsaw, Poland

Sponsored by SPIF

Cooperating Organisations
Innovation Centre for Sensor and Imaging Systems (United Kingdom)
ADS Scotland (United Kingdom)
The Knowledge Transfer Network (United Kingdom)
Visit Scotland (United Kingdom)
European Regional Development Fund (Belgium)
Technology Scotland (United Kingdom)
European Association of Remote Sensing Companies (Belgium)
European Association of Remote Sensing Laboratories (Germany)
The British Association of Remote Sensing Companies (United Kingdom)
Remote Sensing & Photogrammetry Society (United Kingdom)

Published by SPIF

**Volume 10421** 

Proceedings of SPIE 0277-786X, V. 10421

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

Remote Sensing for Agriculture, Ecosystems, and Hydrology XIX, edited by Christopher M. U. Neale, Antonino Maltese, Proc. of SPIE Vol. 10421, 1042101 © 2017 SPIE · CCC code: 0277-786X/17/\$18 · doi: 10.1117/12.2293002

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIEDigitalLibrary.org.

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in Remote Sensing for Agriculture, Ecosystems, and Hydrology XIX, edited by Christopher M. U. Neale, Antonino Maltese, Proceedings of SPIE Vol. 10421 (SPIE, Bellingham, WA, 2017) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510613065

ISBN: 9781510613072 (electronic)

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445

SPIE.org

Copyright © 2017, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/17/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.



**Paper Numbering:** Proceedings of SPIE follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

## **Contents**

vii	Authors
ix	Conference Committee
xi	Introduction
SESSION 1	SURFACE AND GROUNDWATER HYDROLOGY I
10421 02	Automated flood extent identification using WorldView imagery for the insurance industry [10421-1]
10421 03	Flood monitoring technique based on RGB composite imagery using MODIS data [10421-2]
10421 04	Calibration and validation of a semi-distributed hydrological model in the Amur River Basin using remote sensing data [10421-3]
SESSION 2	SURFACE AND GROUNDWATER HYDROLOGY II
10421 05	Multisensor satellite data for water quality analysis and water pollution risk assessment: decision making under deep uncertainty with fuzzy algorithm in framework of multimodel approach [10421-5]
10421 06	Modelling spatial and temporal variability of hydrologic impacts under climate changes over the Nenjiang River Basin, China [10421-6]
SESSION 3	HYDROLOGY AND PRECIPITATION
10421 09	Validation of a global satellite rainfall product for real time monitoring of meteorological extremes [10421-8]
10421 0C	Assessment of TRMM 3B43 product for drought monitoring in Singapore [10421-11]
10421 0D	Evaluation of TRMM 3B42V7 product on extreme precipitation measurements over peninsular Malaysia $[10421-12]$
SESSION 4	EVAPOTRANSPIRATION AND LST
10421 OE	Continuous monitoring of evapotranspiration (ET) overview of LSA-SAF evapotranspiration products [10421-13]
10421 OF	Surface temperature estimated with Landsat 8 images and geostatistical tools in the northwestern São Paulo state [10421-14]

10421 0G	Assessing actual evapotranspiration via surface energy balance aiming to optimize water and energy consumption in large scale pressurized irrigation systems [10421-15]
10421 OH	A random forest and superpixels approach to sharpen thermal infrared satellite imagery [10421-16]
10421 01	Low-cost photonic sensors for carbon dioxide exchange rate measurement [10421-17]
10421 OJ	Determination of the actual evapotranspiration by using remote sensing methods [10421-18]
SESSION 5	VEGETATION MONITORING I
10421 OL	Spectral response of healthy and damaged leaves of tropical seagrass Enhalus acoroides, Thalassia hemprichii, and Cymodocea rotundata [10421-20]
10421 0N	A new comprehensive index for drought monitoring with TM data [10421-22]
SESSION 6	VEGETATION MONITORING II
10421 OP	Spectro-spatial relationship between UAV derived high resolution DEM and SWIR hyperspectral data: application to an ombrotrophic peatland [10421-25]
SESSION 7	SOIL MONITORING
10421 OS	SOIL MONITORING  Directional optical transmission through a sand layer: a preliminary laboratory experiment [10421-30]
	Directional optical transmission through a sand layer: a preliminary laboratory experiment
10421 OS	Directional optical transmission through a sand layer: a preliminary laboratory experiment [10421-30]  Light transmission through a sand layer: modeling changes due to illumination direction
10421 OS 10421 OT	Directional optical transmission through a sand layer: a preliminary laboratory experiment [10421-30]  Light transmission through a sand layer: modeling changes due to illumination direction [10421-31]  Elevation effect on TVDI-based soil moisture retrieval algorithm using MODIS LST and NDVI
10421 OS 10421 OT 10421 OU	Directional optical transmission through a sand layer: a preliminary laboratory experiment [10421-30]  Light transmission through a sand layer: modeling changes due to illumination direction [10421-31]  Elevation effect on TVDI-based soil moisture retrieval algorithm using MODIS LST and NDVI products [10421-32]  Modeling soil organic matter (SOM) from satellite data using VISNIR-SWIR spectroscopy and PLS regression with step-down variable selection algorithm: case study of Campos
10421 OS 10421 OT 10421 OU 10421 OV	Directional optical transmission through a sand layer: a preliminary laboratory experiment [10421-30]  Light transmission through a sand layer: modeling changes due to illumination direction [10421-31]  Elevation effect on TVDI-based soil moisture retrieval algorithm using MODIS LST and NDVI products [10421-32]  Modeling soil organic matter (SOM) from satellite data using VISNIR-SWIR spectroscopy and PLS regression with step-down variable selection algorithm: case study of Campos Amazonicos National Park savanna enclave, Brazil [10421-64]
10421 0S 10421 0T 10421 0U 10421 0V SESSION 8	Directional optical transmission through a sand layer: a preliminary laboratory experiment [10421-30]  Light transmission through a sand layer: modeling changes due to illumination direction [10421-31]  Elevation effect on TVDI-based soil moisture retrieval algorithm using MODIS LST and NDVI products [10421-32]  Modeling soil organic matter (SOM) from satellite data using VISNIR-SWIR spectroscopy and PLS regression with step-down variable selection algorithm: case study of Campos Amazonicos National Park savanna enclave, Brazil [10421-64]  FORESTRY  Mapping forest disturbance and recovery for forest dynamics over large areas using

SESSION 9	EVAPOTRANSPIRATION AND IRRIGATION
10421 12	Water and vegetation indices by using MODIS products for eucalyptus, pasture, and natural ecosystems in the eastern São Paulo state, Southeast Brazil [10421-42]
SESSION 10	VEGETATION MONITORING IN AGRICULTURE I
10421 16	Pilot utilization plan for satellite data-based service for agriculture in Poland [10421-47]
10421 18	Temporal analysis of vegetation indices related to biophysical parameters using Sentinel 2A images to estimate maize production [10421-83]
SESSION 11	VEGETATION MONITORING IN AGRICULTURE II
10421 19	Estimation of winter wheat canopy nitrogen density at different growth stages based on Multi-LUT approach [10421-49]
10421 1A	Applications of Sentinel-2 data for agriculture and forest monitoring using the absolute difference (ZABUD) index derived from the AgroEye software (ESA) [10421-50]
10421 1B	Evaluation and cross-comparison of vegetation indices for crop monitoring from sentinel-2 and worldview-2 images [10421-79]
10421 1D	Mapping agroecosystem zone using remote sensing for food security analysis in Bantul district Daerah Istimewa Yogyakarta [10421-53]
10421 1E	Estimation of leaf water contents from mid- and thermal infrared spectra by coupling genetic algorithm and partial least squares regression [10421-54]
	JOINT SESSION: RADAR
10421 1F	Applying a particle filtering technique for canola crop growth stage estimation in Canada [10421-55]
10421 1G	Object-based land cover classification based on fusion of multifrequency SAR data and THAICHOTE optical imagery $[10421-56]$
	POSTER SESSION
10421 11	Water indicators based on SPOT 6 satellite images in irrigated area at the Paracatu River Basin, Brazil [10421-58]
10421 1L	Detection of a reservoir water level using shape similarity metrics [10421-61]
10421 1M	Study the impact of rainfall on the United Arab Emirates dams using remote sensing and image processing techniques [10421-62]

10421 1N	Monitoring total nitrogen content in soil of cultivated land based on hyperspectral technology [10421-63]
10421 10	Remote sensing of soil organic matter of farmland with hyperspectral image [10421-65]
10421 1Q	Multitemporal WorldView satellites imagery for mapping chestnut trees [10421-67]
10421 1R	Evaluation of forest fires in Portugal Mainland during 2016 summer considering different satellite datasets [10421-68]
10421 15	Carpathian mountain forest vegetation and its responses to climate stressors [10421-69]
10421 1U	Comparison of different discriminant functions for mangrove species analysis in Matang Mangrove Forest Reserve (MMFR), Perak based on statistical approach [10421-70]
10421 1X	Competition between agricultural, urban, and sand-mining areas at the Paraíba do Sul basin in southeastern Brazil [10421-73]
10421 1Z	The fusion of satellite and UAV data: simulation of high spatial resolution band [10421-76]
10421 21	Unmanned Aerial Vehicle (UAV) data analysis for fertilization dose assessment [10421-78]
10421 23	Changes in ecosystem service values in Zhoushan Island using remote sensing time series data [10421-81]
10421 24	Combining optical remote sensing data with in-situ measurements in order to estimate vegetation parameters on agricultural fields and corresponding uncertainties [10421-84]
10421 26	Fusion of radar and optical data for mapping and monitoring of water bodies [10421-86]
10421 27	Evaluation of crop development stages with TerraSAR-X backscatter signatures (2010-12) by using Growing Degree Days [10421-87]
10421 29	Contribution of the new satellites (Sentinel-1, Sentinel-2 and SPOT-6) to the coastal vegetation monitoring in the Pays de Brest (France) [10421-89]

#### **Authors**

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Al Besher, Shaikha A., 1M Al Mansoori, Saeed H., 1M Al Marzouqi, Fatima A., 1M Ali, Asad, 1E

Alonso-Benito, A., 1Q Amaral, A., 1R

Amorim, Mariana de, 1X

Arbelo, M., 1Q Arboleda, A., 0E

Arroyo-Mora, J. Pablo, OP Arshad, Muhammad, 1E Artemenko, Igor, 05 Awada, H., 0G Ba, Antoine, 0X Ban, Hyunju, 03, 0U Baschir, Laurentiu V., 1S Bayma-Silva, Gustavo, 12, 11

Beh, Boon Chun, 1U Bieda, Marcin S., 0I Bora, Eser, 0J Borini Alves, D., 0V Bougault, Christophe, 29

Brindha, K., 0C

Cánovas-García, Fulgencio, 09

Capodici, Fulvio, 1L Chanioti, Maroulio, 21 Chen, Hao, 06 Chua, Vivien P., 0C Ciraolo, G., 0G Còrcoles, J. I., 0G

Cordeiro, Guilherme P. L., 1X

Coslu, Mesut, OZ Dalezios, Nicolas R., 1B Dardanelli, Gino, 1L

de C. Teixeira, Antônio Heriberto, 0F, 12, 11, 1X

de Kok, R., 1A Dercas, Nicholas, 1B, 21 Dida, Adrian I., 1S Dufour, Simon, 0X Galdino, Sergio, 1X García-Galiano, Sandra, 09 García-Pedrero, Angel, 0H Gatkowska, Martyna, 16

Geller, Christina, 02 Ghilain, N., 0E Gong, Fang, 23

Gonzalo-Martín, Consuelo, 0H

Gellens-Meulenberghs, F., 0E

Gu, Xiaohe, 1N, 10

Haywood, Andrew, 0W Hernandez, Fernando B. T., 0F Hernández-Leal, P. A., 1Q Heupel, Katharina, 24 Hislop, Samuel, 0W Hong, S., 03 Hong, Sungwook, 0U Hosseini, Mehdi, 1F Hubert-Moy, Laurence, 0X

Ishaa, Atif, 27

Jenerowicz, Agnieszka, 1Z, 26

Jiao, Xianfeng, 1F Jones, Simon D., 0W Kalacska, Margaret, 0P Kamal, Muhammad, 0L Karbalaee, Negar, 09 Kavvadias, Antonis, 21

Kawakubo, Fernando Shinji, 18

Khurshid, Khurram, 1E Kopachevsky, Ivan, 05 Kostyuchenko, Yuriy V., 05 Kwon, Young-Joo, 03, 0U La Loggia, Goffredo, 1L Laslier, Marianne, 0X Lau, Alvin M. S., 0D Leblanc, George, 0P

Leivas, Janice F., 0F, 12, 11, 1X

Lesiak, Piotr, 0l Li, Chaokui, 23 Li, Na, 19 Li, Yifeng, 1F Li, Zhenhai, 19 Li, Zhenhong, 19

Lillo-Saavedra, Mario, 0H Lim, Hwee San, 1U Liu, Chang, 19 Lo Brutto, Mauro, 1L Lucanus, Oliver, 0P

Lv, Ying, 23 Macedo, Lucas Saran, 18 Maltese, Antonino, 0G, 1L Marchetti, F., 1Q

Mat Jafri, Mohd. Zubir, 1U McNairn, Heather, 1F

Migo, L., 1A

Momesso, Renato F. A., 0F Monteiro Garçon, Edlene A., 12, 11

Montorio Lloveria, R., 0V Moreno Hidalgo, M. A., 0G Moreno-Ruíz, J. A., 1Q Murti, Sigit Heru, 1D Nguyen, Huy Trung, 0W Niculescu, Simona, 29 Nuñez, Daniel N. C., 0F Onur, Isin, 0Z Orych, Agata, 1Z

Orycn, Agata, 12
Papież, M., 1A
Paradowski, Karol, 16
Paska, Jacquoelyne, 0D
Pasternak, René, 27
Perez-Cabello, F., 0V
Philpot, William D., 0S, 0T
Pipitone, Claudia, 1L
Provenzano, G., 0G

Psomiadis, Emmanouil, 1B, 21

Qin, Yanpei, 23

Rodriguez-Esparragón, Dionisio, 0H Ronquim, Carlos Cesar, 12, 11, 1X

Rosero-Vlasova, O., 0V Savastru, Dan M., 1S Savastru, Roxana S., 1S Selim, Serdar, OZ

Sellin, Vanessa, 29 Sinha, Abhijit, 1F

Siok, Katarzyna, 1Z, 26

Sobotka, Piotr, Ol

Soffer, Raymond, OP

Sonmez, Namik Kemal, 0Z Soto-Berelov, Mariela, 0W

Spengler, Daniel, 24

Spyropoulos, Nikolaos V., 1B

Srestasathiern, Panu, 1G

Sukawattanavijit, Chanika, 1G

Sztoyka, Yulia, 05

Talab-Ou-Ali, Halima, 29

Tan, Kok Chooi, OC, OD, 1U

Tan, Mou Leong, OC, OD

Tan, Weikai, 1F

Tautan, Marina N., 1\$

Teodoro, A. C., 1R

Tian, Jia, OS, OT

Toulios, Leonidas, 21

Tsitouras, Alexandros, 21

Ullah, Saleem, 1E

Vlassova, L., 0V

Wang, Jianwen, 19

Wang, Lei, 10

Wang, Lizhi, 1N

Wang, Yuanyuan, 0N

Weltzien, Cornelia, 24

Wessollek, Christine, 27

Wężyk, P., 1A

Wicaksono, Pramaditya, OL

Woliński, Tomasz R., Ol

Woroszkiewicz, Malgorzata, 1Z

Wróbel, Karolina, 16

Yang, Guijun, 1N, 1O

Yuschenko, Maxim, 05

Zhang, Liyan, 1N, 1O

Zhang, Wanchang, 04, 06 Zhang, Xiaoping, 23 Zhen, Guangwei, 23 Zhou, Shilun, 04 Zoran, Maria A., 1S

viii

### **Conference Committee**

Symposium Chair

**Klaus Schäfer**, (*Retired*) Karlsruhe Institute of Technology, Institute of Meteorology and Climate Research (Germany)

Symposium Co-chair

**Christopher M. U. Neale**, University of Nebraska-Lincoln (United States), Daugherty Water for Food Institute (United States)

Conference Chairs

**Christopher M. U. Neale**, University of Nebraska Lincoln (United States) **Antonino Maltese**, Università degli Studi di Palermo (Italy)

Conference Programme Committee

**Wim G. M. Bastiaanssen**, UNESCO-IHE Institute for Water Education (France)

**Antonino Maltese**, Università degli Studi di Palermo (Italy) **Christopher M. U. Neale**, University of Nebraska Lincoln (United States)

#### Session Chairs

- Surface and Groundwater Hydrology I
  Christopher M. U. Neale, University of Nebraska Lincoln (United States)
- 2 Surface and Groundwater Hydrology II Christopher M. U. Neale, University of Nebraska Lincoln (United States)
- 3 Hydrology and Precipitation Antonino Maltese, Università degli Studi di Palermo (Italy)
- 4 Evapotranspiration and LST **Christopher M. U. Neale**, University of Nebraska Lincoln (United States)
- Vegetation Monitoring I
   Christopher M. U. Neale, University of Nebraska Lincoln (United States)
- Vegetation Monitoring II
   Christopher M. U. Neale, University of Nebraska Lincoln (United States)

- 7 Soil Monitoring
  Antonino Maltese, Università degli Studi di Palermo (Italy)
- 8 Forestry
  Antonino Maltese, Università degli Studi di Palermo (Italy)
- 9 Evapotranspiration and Irrigation Antonino Maltese, Università degli Studi di Palermo (Italy)
- Vegetation Monitoring in Agriculture IChristopher M. U. Neale, University of Nebraska Lincoln (United States)
- Vegetation Monitoring in Agriculture IIChristopher M. U. Neale, University of Nebraska Lincoln (United States)

Joint Session: Radar

Nazzareno Pierdicca, Sapienza – Università di Roma (Italy) Antonino Maltese, Università degli Studi di Palermo (Italy)

#### Introduction

This proceedings volume contains papers presented during the conference on Remote Sensing for Agriculture, Ecosystems, and Hydrology. The conference was part of the International Symposium on Remote Sensing sponsored by SPIE—The International Society for Optical Engineering. The symposium was held at the Doubletree Hilton Hotel, Warsaw, Poland, from 11th to 14th of September 2017.

Approximately 35 oral and 15 poster papers were presented during this year's conference, covering a broad range of topics in the field of remote sensing applications in environmental science.

The program was organized into 11 sessions according to major themes, namely Surface and Groundwater Hydrology (2), Hydrology and Precipitation, Evapotranspiration and Land Surface Temperature, Vegetation Monitoring (2), Soil Monitoring, Forestry, Evapotranspiration and Irrigation, Vegetation Monitoring in Agriculture (2), and finally a Joint Session on Radar with the "Active and Passive Microwave Remote Sensing for Environmental Monitoring" Conference.

The poster presentations also had good representation from the above-mentioned themes. The presentations described both fundamental and applications-based research activities including modelling, laboratory and field experiments, and operational applications.

Our appreciation and gratitude goes also to the presenters for their efforts and to the participants for their insightful questions and discussions. Special thanks are also due to the host city for the excellent venue and to all the SPIE organizational staff for their support prior to, during, and after the symposium. We look forward to an even more successful conference in 2018 in Berlin, Germany.

Christopher M. U. Neale Antonino Maltese