Editorial
Foreword to the Special Issue on Recent Advances in Multitemporal Remote-Sensing Data Processing

I. INTRODUCTION

THANKS to the revisit property of Earth observation (EO) satellites, continuous monitoring of large areas of the Earth's surface with high-resolution sensors benefits many scientific goals and various remote-sensing applications.

The enhanced capability of acquiring multitemporal remote-sensing images and the advanced analytical techniques significantly increase the interest of the remote-sensing community in the multitemporal domain and allow addressing new important and challenging applications. In the past decades, the evolution of the multitemporal analysis has evolved from bitemporal change detection (CD) methods to signal-processing methods for the analysis of long image sequences, and from single-sensor approaches to multisensor synergy and fusion methods. This evolution not only originates from technological development in sensor systems and data analytics and the availability of a multitude of high-quality EO data from a wide range of instruments, but also from emerging societal challenges that require multisource and multitemporal observations to meet multifarious user requirements. Accordingly, advanced and robust techniques are ever urgently required to address the emerging new challenges and issues from the methodological and practical application viewpoints.

During August 5–7, 2019, the 10th International Workshop on the Analysis of Multitemporal Remote Sensing Images (MultiTemp 2019) was successfully held in Shanghai, China. It is the first time of this worldwide prestigious biannual conference came to Asia, since its inauguration in Trento, Italy, in 2001. Including the Permanent Steering Committee Chair, Prof. Lorenzo Bruzzone, the General Chairs, Prof. Xiaohua Tong from the Tongji University and Prof. Qian Du from the Mississippi State University, and the Technical Co-Chairs Prof. Bovolo Francesca from the Fondazione Bruno Kessler and Prof. Sicong Liu from Tongji University, 159 participants from 12 countries around the world gathered in Shanghai, to share their recent novel solutions to technical problems and developments related to multitemporal data analysis. Fifteen sessions were arranged in the conference program, covering a wide range of specific topics in multitemporal data analysis such as CD in multisource data (e.g., SAR, VHR, hyperspectral and nighttime light images), methodological problems (e.g., quality assessment, domain adaptation, transfer learning, deep learning, data fusion), and various applicative issues in diverse fields (e.g., urban, vegetation, cryosphere, ecosystem, planetary exploration).

This Special Issue of the IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING (JS-TARS) contains 11 articles both from the extended outcomes of the MultiTemp 2019 presented articles, and from the submissions by following a general Call-for-Papers of this Special Issue. These articles focus on the following interesting and relevant topics in the multitemporal data analysis.

1) *Pre-/postprocessing:* Liu *et al.* presented a radiometric normalization method for multitemporal high-resolution satellite images during mosaicking by using iteratively reweighted radiometric adjustment without master images; Zhu *et al.* developed a hybrid multitemporal relearning method to improve the classification accuracy by using three CNN models with two relearning strategies.
2) *Information fusion:* Wang *et al.* designed a feature fusion approach to integrate the pixel-level, neighborhood-level, object-level, and scene-level features for CD; Wu *et al.* developed a universal spatiotemporal fusion method when only two input images are available; and Zheng *et al.* proposed a multitemporal deep fusion network (MDFN) for short-term multitemporal high-resolution images classification.
3) *High resolution CD:* Zhan *et al.* presented a three-direction spectral–spatial convolution neural network (TDSSC) for CD in hyperspectral images; Wang *et al.* proposed a deep domain adaptation method based on graph neural network (GNN) for multitemporal hyperspectral images; Luo *et al.* developed a subpixel-convolution-based method for CD in high-resolution images.
4) *Heterogeneous CD:* Li *et al.* proposed a spatially self-paced convolutional network (SSPCN) for an unsupervised CD in bitemporal heterogeneous images.
5) *Specific applications:* Zhang *et al.* integrated the precipitation, soil water and heat balance, and crop growth to construct a comprehensive drought monitoring index (CDMI), and applied it to long-term drought monitoring in agricultural areas. Zhang *et al.* utilized the scaled solar-induced chlorophyll fluorescence (SIF) index to monitor and assess monthly agricultural drought during the crop-growing season in agricultural areas of North China Plain (NCP).

This Special Issue showcases the advanced developments in multitemporal remote-sensing data processing. We would like

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Sicong Liu (Senior Member, IEEE) received the B.Sc. degree in geographical information system and the M.E. degree in photogrammetry and remote sensing from the China University of Mining and Technology, Xuzhou, China, in 2009 and 2011, respectively, and the Ph.D. degree in information and communication technology from the University of Trento, Trento, Italy, 2015.

He is currently an Associate Professor with the College of Surveying and Geo-Informatics, Tongji University, Shanghai, China. His research interests include multitemporal data analysis, change detection, multispectral/hyperspectral remote sensing, and planetary remote sensing.

Dr. Liu was the winner (ranked as third place) of Paper Contest of the 2014 IEEE GRSS Data Fusion Contest. He is the Technical Co-Chair of the Tenth International Workshop on the Analysis of Multitemporal Remote Sensing Images (MultiTemp 2019). He is the Program Committee Member for SPIE Remote Sensing Symposium: Image and Signal Processing for Remote Sensing XXVI-XXVIII (2020–2022), and was the Session Chair for many international conferences such as International Geoscience and Remote Sensing Symposium (2017–2019). He is/was a Guest Editor for the IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING and *Remote Sensing*.

Francesca Bovolo (Senior Member, IEEE) received the Laurea (B.S.) degree, the Laurea Specialistica (M.S.) degree (*summa cum laude*) in telecommunication engineering, and the Ph.D. degree in communication and information technologies from the University of Trento, Trento, Italy, in 2001, 2003, and 2006, respectively.

She was a Research Fellow with the University of Trento, until 2013. She is currently the Founder and the Head of Remote Sensing for Digital Earth Unit, Fondazione Bruno Kessler, Trento, and a member of the Remote Sensing Laboratory, Trento. She is one of the co-investigators of the Radar for Icy Moon Exploration instrument of the European Space Agency Jupiter Icy Moons Explorer and a member of the science study team of the EnVision mission to Venus. She conducts research within the context of several national and international projects on the topics of her research interests, which include remote-sensing image processing, multitemporal remote-sensing image analysis, change detection in multispectral, hyperspectral, and synthetic aperture radar images, and very high-resolution images, time series analysis, content-based time series retrieval, domain adaptation, and Light Detection and Ranging (LiDAR) and radar sounders.

Dr. Bovolo is a member of the program and scientific committee of several international conferences and workshops. She was a recipient of the First Place in the Student Prize Paper Competition of the 2006 IEEE International Geoscience and Remote Sensing Symposium (Denver, 2006). She was the Technical Chair of the Sixth International Workshop on the Analysis of Multitemporal Remote-Sensing Images (MultiTemp 2011, and 2019). She has been a Co-Chair of the SPIE International Conference on Signal and Image Processing for Remote Sensing since 2014. She is the Publication Chair of the International Geoscience and Remote Sensing Symposium in 2015. She has also been an Associate Editor for the IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING since 2011 and the Guest Editor of the Special Issue on Analysis of Multitemporal Remote Sensing Data of the IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING. She is a Referee for several international journals.

Lorenzo Bruzzone (Fellow, IEEE) received the Laurea (M.S.) degree in electronic engineering (*summa cum laude*) and the Ph.D. degree in telecommunications from the University of Genoa, Genoa, Italy, in 1993 and 1998, respectively.

He is currently a Full Professor of Telecommunications with the University of Trento, Trento, Italy, where he teaches remote sensing, radar, and digital communications. He is the founder and the Director of the Remote Sensing Laboratory, Department of Information Engineering and Computer Science, University of Trento. He is the author (or coauthor) of 294 scientific publications in referred international journals (221 in IEEE journals), more than 340 papers in conference proceedings, and 22 book chapters. He is editor/co-editor of 18 books/conference proceedings and one scientific book. He promotes and supervises research within the frameworks of many national and international projects on the topics of his research interests, which include remote sensing, radar and SAR, signal processing, machine learning, and pattern recognition.

Dr. Bruzzone was the Principal Investigator of many research projects. Among the others, he is currently the Principal Investigator of the Radar for Icy Moon Exploration (RIME) instrument in the framework of the Jupiter Icy Moons Explorer (JUICE) mission of the European Space Agency (ESA) and the Science Lead for the High Resolution Land Cover project in the framework of the Climate Change Initiative of ESA. His papers are highly cited, as proven from the total number of citations (more than 40 000) and the value of the h-index (92) (source: Google Scholar). He was invited as a Keynote Speaker in more than 40 international conferences and workshops. Since 2009, he has been a Member of the Administrative Committee of the IEEE Geoscience and Remote Sensing Society (GRSS), where since 2019, he has been the Vice-President for Professional Activities. ranked first place in the Student Prize Paper Competition of the 1998 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Seattle, July 1998. He was the recipient of many international and national honors and awards, including the recent IEEE GRSS 2015 Outstanding Service Award, the 2017 and 2018 IEEE IGARSS Symposium Prize Paper Awards, and the 2019 WHISPER Outstanding Paper Award. He was a Guest Co-Editor of many Special Issues of international journals. He is the Co-Founder of the IEEE International Workshop on the Analysis of Multi-Temporal Remote-Sensing Images (MultiTemp) series and is currently a member of the Permanent Steering Committee of this series of workshops. Since 2003, he has been the Chair of the SPIE Conference on Image and Signal Processing for Remote Sensing. He has been the founder of the *IEEE Geoscience and Remote Sensing Magazine* for which he has been Editor-in-Chief between 2013 and 2017. He is currently an Associate Editor for the IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING. He has been *Distinguished Speaker* of the IEEE Geoscience and Remote Sensing Society between 2012 and 2016.

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