Foreword to the Special Issue on Human Settlement Monitoring Using Multiple Earth Observation Data

***Abstract*—This special issue follows the very successful series of the Joint Urban Remote Sensing Events (JURSE), held every two years since 2005. The possibility to jointly use optical and radar VHR data, as well as different sensors from the same or related airborne and spaceborne platforms, at a level which may be regional or global according to the situation, open the path for more researches oriented to the analysis of multiple data for urban monitoring at different geographical scales. Submitted and selected papers include works on land cover/land use mapping using SAR and/or optical data in urban areas, monitoring land cover/land use and environmental changes in urban areas, change detection/feature extraction/data fusion for urban scene interpretation, human settlement monitoring and change modeling using remotely sensed data. They show recent research trends, and highlight primary keys to the future of urban remote sensing.**

***Index Terms*—Human settlements, urban remote sensing, VHR images.**

I. Introduction

THE use of remotely sensed data for characterizing human settlements is by no means a new topic. Since the beginning of the Earth observation era, focus has been on urban areas as crucial elements of the interaction between mankind and natural environments. However, while the topic is not new in itself, it is interesting the shift that it has been experiencing in research. From the first works on single image of one part of the world, recent works and books [1]–[5] have moved to data, global coverage and multiple data sources with—if possible—multiple spatial resolution. It is no surprise that, with Earth Observation (EO) data archives becoming richer and richer, data is more often provided free of charge to the researchers, and this availability leads to analyses considering much more than a single data set. It is also important to stress that the current trend towards the availability for free of the data collected by scientific satellites, coupled with the ubiquitous capabilities of internet and cloud services, provide an excellent and unprecedented set of data to be exploited by means of new, computationally efficient and, whenever possible, distributed processing techniques.

This shift is one of the reasons that makes urban remote sensing an ever challenging and extremely interesting research topic, that attracts hundreds of participants to the Joint Urban Remote Sensing Event (JURSE) workshops. Since 2005, the JURSE event merged the International Conference on Urban Remote Sensing (URS) and the IEEE GRSS/ISPRS Joint Workshop on ‘Data Fusion and Remote Sensing over Urban Areas” (URBAN) into one single event, each time more significant and more interesting. The last event in the series was held in May 2011 in Munich, Germany, a city with a strong tradition, a long and glorious history and a very active and successful present. According to its usual numbers, JURSE 2011 gathered people involved in research on the topic of urban remote sensing coming from 28 countries in five continents at Technische Universitaet Muenchen. In addition to oral and poster sessions, the workshop featured three Special Sessions with invited talks were organized by researchers well-known in their own specific fields, including a Session on the Urbanization project within the Dragon 2 program, sponsored by the European Space Agency (ESA) and the Chinese Ministry of Science and Technology. Finally, and as a very welcome addition started in 2009, ESA sponsored also the Student Prize competition, very well attended, showing the interest by young researchers for this active field.

This Special Issue is the result of the tremendous effort to organize this successful event, and attempts to provide some glimpses on the current trends in human settlement monitoring using multiple EO data. It naturally follows the first JSTARS issue [6], published after JURSE 2007, and the second one [7], assembled following JURSE 2009.

II. Recent Trends in Human Settlement Monitoring Using Multiple EO Data

The collection of topics proposed in this issue follows directly the shift discussed in the Introduction. On the one hand, analysis has become a normal situation as opposed to a special case. On the other hand, multiple sensors and data sets are compared and co-investigated to achieve a better characterization of urban parameters. This often brings naturally to collecting data set from different space agencies or companies, and developing methodologies able to work on multiple data. This is in line with another trend, i.e., international cooperation for EO-based studies, which has been recently fueled by climate-change related studies and international efforts to cope with natural hazards. In this sense, the recent approval by the Global Earth Observation (GEO) committee of a task related to “Global Urban Observatory” in its 2012–2014 working plan is a much deserved recognition to the urban remote sensing community already globally collaborating to this aim.

Specifically, a fist group of papers is devoted to urban area monitoring and change detection using both multispectral and SAR data. Applications are both long-term (urban sprawl, built-up area change detection) and short-term ones (damage detection after earthquakes or conflicts). The first paper in this group [8] applies to two different types of multispectral data a combination of multiple generalized difference images, showing that it can lead to consistent improvements for “hot spots” detection in large urban areas. By means of tests in the same area, the P.R. of China, the paper by Ban and Yousif [9] shows that effective change monitoring using SAR data is also possible, provided the right probability density function to model amplitude SAR data in urban areas is picked. On the same line, the work proposed in [10] applies wavelet decomposition to estimate the probability density function parameters

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for the same data typology and the same problem. With respect to sudden changes due to natural events, the work by Cossu *et al.* [11] is the perfect example of a smart use of archived coarse resolution SAR data to set up an innovative service using state-of-the-art parallel processing facilities. Klonus *et al.* [12] present a methodology to fuse spatial features to extract damages in crisis areas from very high-resolution optical data, complementing the full range of spatial and spectral resolution for a very similar task.

A second group focuses on the joint exploitation of, multi-polarimetric or multi-sensor data for urban area mapping, still with focus on urban monitoring by exploiting existing and future data sets. Within this group, the paper by Niu and Ban [13] explores the possibility to exploit multi-temporal polarimetric data sets, while Gamba and Aldrighi [14] show that a joint combination of textural features from SAR data and segmentations as well as spectral features from multispectral data lead to a better recognition of urban blocks and their labelling according to urban land use classes. The third paper in this group, [15] discusses the relevance and usefulness of resolution-invariant statistical distributions for PolSAR data, able to fit—and thus classify—measurements recorded by very different SAR platforms. The work by Graesser *et al.* [16] exploits textural features at various spatial scales to discriminate between formal and informal neighborhoods using very high-resolution multispectral images.

Finally, the last two papers are devoted to the use of hyperspectral and thermal data to extract information about the urban environment. The work by Liao *et al.* [17] explores the use of morphological profiles with partial reconstructions for the classification of urban areas, while in [18] the focus is on the use of multiple EO data for the recognition of Urban Climate Zones. The latter paper highlights the possibility to evaluate coarse spatial and spectral resolution data for urban morphological analysis, a new topic which is under investigation because of the implications in local and regional climate models.

As a final comment to this special issue, it is interesting to note that the following papers well complement the "regular" one published in this journal between the last and the current human settlement special issues and devoted to very similar topics. Specifically, we refer to:

- urban area subsidence monitoring using radar interferometry [19];
- urban "3D-scape" characterization [20]–[22];
- building extraction and characterization [23], [24];
- urban mapping using multi-angular or multi-resolution data sets [25], [26].

Together with those proposed in this issue, we expect also these lines to be equally active in the future, and we welcome submissions to future JURSE and special issues by research groups working in these areas.

III. Conclusion

This issue represents the third issue of a series published on this prestigious journal since 2008. The urban remote sensing community looks forward to these Special Issues as a showcase of recent activities presented to the workshop and a milestone. No doubt that we will keep the tradition flowing following JURSE 2013, on April 21–23, 2013 in Sao Paulo, Brazil, hosted by INPE, the Brazilian National Institute for Spatial Research. For more details and the call for papers, please visit the workshop website at http://www.inpe.br/jurse2013!

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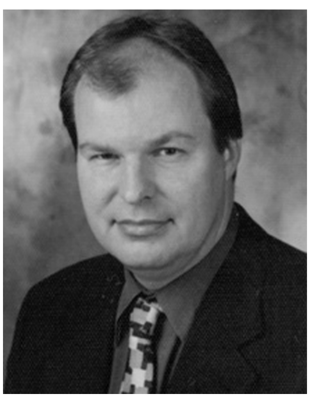

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