

Editorial

Editorial of Special Issue “Remote Sensing for Land Cover/Land Use Mapping at Local and Regional Scales”

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1. Introduction

More than ever, there is a need from policy and decision makers, national governments, non-governmental organizations, international initiatives, scientists, and individual citizens for timely and accurate spatially-explicit information on Earth’s physical surface cover and the socio-economic function of land at multiple scales. Information on land-cover, land-use patterns and monitoring of their changes, can support regional policies and local action for sustainable development in terms of efficiency in resources use, disaster risk reduction, and environmental protection.

Since the process and driving forces of change usually operate at multiple scales, it is important to capture and synthesize information on the land-cover and land-use patterns in regional, wall-to-wall maps, as well as at sub-regional, national, and local scales.

Nowadays, the availability of satellite data with improved characteristics at low or no cost, the technological evolution of Unmanned Aerial Systems (UAS) in terms of autonomy and payload capacity, the introduction of robust algorithms, and the advent of data processing and distribution technology, have motivated the progress of research and efforts from the remote-sensing community to cover the information needs on land use/land cover mapping at appropriate scales.

However, several challenges still exist, related to the development of stable processing approaches, local and regional products with higher spatial and temporal resolutions, as well as improved thematic content, multi-sensor and multi-platform fusion (i.e., UAS-satellites), web-processing services and big data analysis, consistency and harmonization of the information content among existing regional and local products, data gaps, and lack of standardized validation procedures, among others.

This Special Issue continues a long line of related studies that present the development of new methodological approaches, exploitation of new data sources and generation of operational products for Earth’s land use/land cover status and monitoring changes.

By presenting many important problems as well as corresponding state-of-the-art technologies and methodologies regarding the land use/land cover domain, this Special Issue aspires to stimulate further research in the Remote Sensing (RS) community. In the near-future, further developments related to sensor characteristics, algorithms (i.e., near-real time, big-data), and improvements in end-user data access will certainly allow the remote sensing scientists to provide unprecedented information to the general public, policy makers, and science communities.

The following Section delivers a summary of all the 10 articles published in the current special issue. Land use and land cover mapping is full connected with change detection and quantification [1], and four [2–5] of the Special Issue articles, apart from generating local to regional Land-Use/Land-Cover (LULC) products with innovative or state-of the art methods, also analyzed multi-temporal change trajectories. Multi-temporal Landsat imagery was used in six of the articles [2–7], while two contributions [8,9] were developed using more complex hyperspectral and Light Detection and Ranging (LiDAR)/radar Earth Observation (EO) data. Four articles [3,5,6,9] presented approaches relying on EO data fusion, in line with the large number of available Earth Observation sensors. One article addressed an important issue related to the comparison and assessment of operational global and continental land cover products [10].

2. Overview of Contributions

In order to study regional and global environmental and processes and changes, accurate and reliable LULC products are needed. Information on the accuracy of existing continental and global products is essential for the users and within this framework, Manakos et al. [10] examined the credibility and validity of four moderate-to-high spatial resolution land cover products, over selected areas in south, central and eastern European.

While such land cover products can provide harmonized information across wide areas, facilitating analysis and supra-national decision making without errors arising from different nomenclatures, production approaches, etc., when it comes to local or national applications, higher resolution, reliable products are needed. Based on a kernel density estimation classification approach, Duong et al. [3] produced land cover maps of the Central Vietnam between 2007 and 2017, integrating high-resolution remotely sensed data from Landsat 5, 7, and 8, Sentinel-2, Advanced Land Observing Satellite Advanced Visual, and Near Infrared Radiometer type 2 (ALOS/AVNIR-2), ALOS Phased Array L-band Synthetic Aperture Radar (PALSAR) Mosaic, ALOS-2/PALSAR-2 Mosaic, Shuttle Radar Topography Mission (SRTM), and ancillary data. The final mapping product had a spatial resolution of 10 m and an overall accuracy of more than 90%.

Gounaridis et al. [4] developed a methodological framework for the accurate detection of LULC changes that occurred in the Attica region of Greece over a 25-year period. The classification was implemented using a Random Forests (RF) machine learning algorithm and two Landsat images per year of analysis. The overall classification accuracies of the high thematic resolution maps ranged from 90.5% to 93.5%. In addition, the results of the land use/land cover change analysis, highlighted the relevance of the economic circumstances in Greece in shaping change trajectories.

Pan et al. [2], using a time series of Landsat images, developed an approach for tracking cropping information in 5-year increments between 1990 and 2015 in Cold China. Based on the analysis of the trajectory transformation over this 35-year period, and a cellular automata/Markov Change prediction model the cropping patterns were extrapolated for the epochs of 2020, 2030, 2040, and 2050.

Focusing on paddy fields monitoring, LULC maps for five different years: 1954, 1976, 1986, 2000 and 2015 were produced over Sanjiang Plain in Northeastern China, integrating data from the Landsat satellite missions and UAS imagery. Detailed trajectory analysis quantified both the dynamics of change as well as underpinned the identification of the drivers of the change [5].

At local scale, Zhao et al. [11] developed an approach that can exploit contextual information and improve the classification performance for high-resolution imagery. The developed method starts with the extraction on meaningful semantic segments for accurately capturing geographical objects through the integration of Convolutional Neural Network (CNN) based deep features, with low-level image segments, followed by a graph-based conditional random field model to capture the contextual information for better classification results. At the final stage, they further improved the conditional random fields (CRF)-based classification results by considering higher-order co-occurrences between different geographical objects.

Monitoring and mitigation of degradation processes occurring within the fragile, biodiversity-rich non-forest communities such as grasslands and meadows is a challenging task requiring accurate information on the land cover of these areas. In the study of Marcinkowska-Ochtyra et al. [9], the use of airborne 1-m resolution HySpex and LiDAR data for mapping the distribution of expansive grass species investigated in the Natura 2000 site in Poland at their different growth stages was evaluated. The datasets were classified using a Random Forest algorithm while different feature datasets and different times of airborne data acquisition were also explored.

A classification approach for high-dimensional, high-spatial resolution datasets, based on CNNs that have recently attracted the interest of the RS community for many image classification tasks, was the focus of the study from Carranza et al. [8]. Hyperspectral and radar images were used for developing a 2D convolution CNN architecture for LULC classification. Validation procedures included approaches based on repeated stratified cross-validation tests for each dataset and the Geoscience Remote Sensing Society (GRSS) data and algorithm standard evaluation website competition. The deep learning model was reported not only to be more accurate compared to traditional machine learning algorithms, but also to be the fastest in terms of computation time for both training and testing phases.

Fusion of the information content of Moderate Resolution Imaging Spectroradiometer (MODIS) and Landsat images proved an efficient approach for developing accurate LULC maps for basin planning over the Lower Mekong Basin (LMB) area [6]. A synergistic approach of unsupervised and supervised classification methods, provided accuracies over 80% for a complex (13 LULC classes) classification scheme.

Focusing on the domain of land cover change detection, Lv et al. [7] developed a novel unsupervised method for land cover change detection using bitemporal images. Their approach progressively and adaptively extends a contextual region from a central pixel to a labeled pixel group which is spectrally similar and spatially contiguous. The pairwise adaptive extended region is then set as the space for computing the change magnitude between pairwise pixels of the bi-temporal images. All the bi-temporal images are scanned and processed to generate a change magnitude image. Finally, image thresholding is employed to obtain the binary change detection result.

Conflicts of Interest: The authors declare no conflict of interest.

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