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Editorial

Theme Issue "Multitemporal remote sensing data analysis"

The remote sensing and photogrammetric community has witnessed significant evolution during the last decade and is facing today a new paradigm in data processing and analysis. Indeed, the development of new satellite remote sensing missions leads to an increasing amount of multi-temporal data, with improved spatial, spectral, and temporal resolutions, available at various scales (Berger and Aschbacher, 2012; Belward and Skøien, 2015). In parallel, data becomes available for free, often through dedicated infrastructures, with the opening of satellite and aerial image archives (Landsat and Spot World Heritage, Sentinel missions (Wulder and Coops, 2014)) and with the growing power of benchmark contests, more focused on very high resolution data provision (Benedek and Szirányi, 2009; Rottensteiner et al., 2014; Vallet et al., 2015) or on data fusion (Debes et al., 2014). Consequently, it has never been so easy to collect multiple observations for large areas of the Earth's surface, which has significantly raised the interest of the scientific community and permitted the development of innovative methods for handling and analysing temporal series of (multimodal) datasets (Bovolo et al., 2013).

Even more recently, newest generations of technology and sensors, such as unmanned aerial systems (Colomina and Molina, 2014), mobile mapping vehicles (Paparoditis et al., 2012) and oblique or multi-angular imagery (Longbotham et al., 2012), have become mature. They are natively able to provide repetitive measurements with varying spatial and temporal resolutions and have opened the field for new challenges.

This special issue addresses the problem of the analysis of multi-temporal remote sensing data for mapping, monitoring, and change detection purposes. It gathers 10 method- and application-driven papers, and provides a representative sample of state-of-the-art methods on this topic. These papers were selected out of 25 submitted contributions according to the rigorous standard peer-review process of the ISPRS Journal of Photogrammetry and Remote Sensing. A large range of topics and data is covered including nadir, off-nadir and multi-angular satellite and airborne optical images, 3D point clouds and (polarimetric) synthetic aperture radar (SAR) images. These papers can be divided into three groups, depending on their main purpose: change detection, land-cover mapping, and monitoring.

The first group of five papers deals with change detection (CD) under varying configurations. It can be pairs or time-series of images, high or very high resolutions images or data from the same or two distinct sensors. Qi et al. propose a two-step approach for efficiently analysing pairs of polarimetric RADARSAT-2 images. An object-based unsupervised detection of changes is followed by a semantic interpretation of images so as to better handle speckle noise and reduce false alarm rate. Trajectories of objects are discovered and additionally provide information on the land development. Benedek et al. also work on bi-temporal change detection but focus on optical airborne images. Three multilayer, Markov random field-based frameworks are compared in terms of mathematical modelling and input features using a benchmark dataset, which allow weighting the pros and cons of unsupervised and supervised techniques. An unsupervised approach is adopted by Xiao et al. for comparing 3D point clouds acquired by a mobile laser scanner in an urban environment. An occupancy-grid method coupled to a standard geometrical analysis is embedded into the Dempster–Shafer theory in order to efficiently deal with the high complexity of streets and their irregular sampling with laser scanners. Moreover, the change detection issue can be addressed by the analysis of time-series of images, as performed by Lê et al. For various sensors (ALOS PALSAR, RADARSAT-2, TerraSAR-X) over mountainous areas, the authors analyse stacks of SAR images in order to build a spatio-temporal change detection matrix that can be further processed for three main purposes: filtering, analysis of change dynamics, and multi-temporal change detection, more dedicated to abrupt changes. The final paper focuses on cross-sensor processing. Indeed, for that purpose, Volpi et al. adopt the kernel canonical correlation analysis technique to spectrally align images from distinct sources, typically with varying spectral and spatial resolutions. A fully automatic approach is proposed and offers the advantage of projecting data in a latent space where any kind of standard CD technique can be applied.

The second group of papers focuses on land-cover mapping and how to optimally exploit multiple observations through space and time in order to strengthen or facilitate the discrimination of land-cover classes. First, Wehmann and Liu propose to merge state-of-the-art machine learning and kernel methods into a single spatial–temporal Markovian support vector classifier technique in order to generate a spatial-temporally consistent land-cover product. Applied to Landsat MSS and TM images over the period 1977–2008, this allows the production of more accurate and more stable maps that are therefore more convenient for change detection with post-classification techniques. The second paper by Betbeder et al. investigates the field of selecting the optimal number of images and the best period to discriminate a specific class or pattern among a time-series of images. Herbaceous wetland monitoring at small scale is addressed using polarimetric very high resolution TerraSAR-X data on a yearly-basis. This opens the field for the very accurate remote sensing based monitoring of ecological processes. Matasci et al. eventually assess the potential of multi-angular images acquired by Worldview-2 sensor for urban mapping. On

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the one hand, the study proposes a distance to compare data distributions over varying angles of incidence and statistically analyses the spectral behaviour of images in order to efficiently link them to the physical properties of targets. On the other hand, the authors investigate the portability of two supervised classification techniques according to the off-nadir look angle and show that a non-linear Gaussian support vector machine approach can efficiently cope with angular shift situations.

Contributions from the last group are specifically dedicated to multi-sensor monitoring over large periods of time (e.g., several years). Dutrieux et al. map the forest cover loss over Bolivia by refining the BFAST model: observations from two sensors at two distinct spatial resolutions (here Landsat and MODIS) are coupled with various benefits. Anthropogenic and natural phenomena are more accurately discriminated and disturbances are timely detected, leading to better fitting time-series of images and reducing false alarm rates over large scales. Kim et al. process ERS/ENVISAT and ALOS PALSAR images to map ground displacements in an urban area for the period 1993–2011. A SAR interferogram computational framework for small baselines is proposed. Experiments show that small subsidences can be detected and a large period of time is necessary to comprehend such a complex phenomenon driven by multiple anthropogenic factors.

Finally, we would like to thank all contributing researchers as well as reviewers, spending time on reading and commenting on others research work. We thank the Editor-in-Chief of the ISPRS Journal of Photogrammetry and Remote Sensing, Derek Lichti, for his constant help and outstanding guidance for managing this theme issue, fruitful discussions on journal edition, and, to top it all, for the freedom he gave us to propose and tailor such a special issue. We do not forget that Qihao Weng new co-Editor-in-Chief during the preparation of this volume also provided us strong hints and advice on how to efficiently manage papers in such a high-level journal.

We sincerely hope that this special issue will exceed expectations you may have on such a topic.

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