remote sensing

Editorial

Preface: Remote Sensing for Flood Mapping and Monitoring of Flood Dynamics

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Abstract: This Special Issue is a collection of papers that focus on the use of remote sensing data and describe methods for flood monitoring and mapping. These articles span a wide range of topics; present novel processing techniques and review methods; and discuss limitations and challenges. This preface provides a brief overview of the content.

Keywords: remote sensing; satellite rainfall; flood mapping; flood monitoring; flood modelling

1. Scope

There is no doubt that the socioeconomic impacts associated with floods have been increasing. According to the International Disaster Database (EM-DAT; www.em-dat.be), floods are the most frequent weather-related disaster with the highest impact in terms of the number of people affected. Nearly 0.8 billion people were affected by inundations in the last decade (2006–2015) while the overall economic damage was estimated to be more than $300 billion. Despite this evidence and the growing awareness of the environmental role of rivers and their inundation, our knowledge and modelling capacity of flood dynamics remain poor, which is mainly related to the availability of measurements and ancillary data.

In this context, remote sensing represents a highly valuable source of observation data that could alleviate the decline in field surveys and gauging stations at the global level, especially in remote areas and developing countries. The integration of remotely sensed variables (such as terrain elevation, river width, flood extent, water level, land cover, etc.) with flood modelling promises to considerably improve our processes for understanding and prediction. Furthermore, during the last few decades, an increasing amount of research has been undertaken to better exploit the potential of current and future satellite observations.

In particular, in recent years, the scientific community has shown how remotely sensed variables can potentially play a key role in the calibration and validation of hydraulic models in addition to providing a breakthrough in real-time flood mapping and monitoring applications. Although the number of state-of-the-art and innovative research studies in these areas is increasing, the full potential of remotely sensed data in enhancing flood mapping, modelling and prediction has yet to be unlocked. In this context, the current proliferation of remote sensing techniques from many various airborne and spaceborne platforms will undoubtedly enhance the quality and increase the spatial and temporal coverage of such data, thus offering new opportunities to foster our understanding of flood dynamics and our ability to map and monitor floods at both local and global scales [1].

This Special Issue presents a collection of works that highlight the current efforts in advancing the science and applications of remote sensing for flood monitoring and mapping. The following section provides a brief overview of the large variety of papers in this Special Issue, presenting the use of remote sensing data and describing methods in flood research and applications.

2. Overview of Contributions

The contributing articles cover local events to global scale applications and utilize a range of new methods to improve the classification of flood waters or to aid flood modelling.

Increasing the accuracy and reliability of flood maps created from satellites in wetland environments during extreme events or for global scale applications is still very challenging. For quantifying surface water inundation in wetlands, DeVries et al. [2] presented a fully automated and scalable algorithm. Requiring no external training data, their algorithm estimates the sub-pixel water fraction over large areas and long time periods using Landsat data. Meeting a similar objective, Bangira et al. [3] applied a spectral indices-based unmixing algorithm to medium resolution satellite data (Medium Resolution Imaging Spectrometer, MERIS) over a basin in Namibia to retrieve the fractional abundance of water. Huang et al. [4] introduced an automated extraction algorithm of surface water extent from Sentinel-1 radar imagery to better characterize heterogeneous or variable wetlands. Using Sentinel-2 optical imagery, a fast and automatic data-driven thresholding method for inundation mapping was proposed by Kordelas et al. [5] in order to better distinguish between different types of flooded wetlands. Chaabani et al. [6] investigated the added value of the bistatic TDX/TSX Interferometric Synthetic Aperture Radar (InSAR) coherence and SAR backscatter in the context of inundation mapping in complex environments and compared that to the dynamics of a LISFLOOD-FP flood model simulation.

In the context of extreme flood events or flood disasters, Li et al. [7] applied an independent component analysis of Sentinel-2 imagery in order to characterize geomorphological responses to an extreme event in Bolivia. For flood disaster monitoring, two case studies of Hurricane Harvey were contributed. Goldberg et al. [8] leveraged the combination of image data from sensors aboard the Suomi National Polar-Orbiting Partnership Satellite (SNPP) and the new Geostationary Operational Environmental Satellite (GOES)-16 to produce timely flood maps that were provided to the Federal Emergency Management Agency (FEMA) continuously during the Harvey event. For the same event, Chini et al. [9] tested Sentinel-1 InSAR Coherence to detect flood waters in the urban areas of Houston (TX, USA). For better modelling of flash flood events, especially in arid regions, Mashaly and Ghoneim [10] used a variety of satellite elevation data and images to characterize the surface runoff in the Egyptian desert.

The extraction of flood maps from the long historic archives of satellite images and the application of mapping algorithms for large-scale (national to global) flood monitoring is becoming increasingly popular but also ever more challenging with the steady proliferation of remotely sensed data. In this context, Notti et al. [11] examined the potential and limitations of open-access satellite data (MODIS, Proba-V, Landsat, Sentinel-1 and Sentinel-2). For large-scale applications, Olthof and Tolszczuk-Leclerc [12] integrated the archives from both the RADARSAT and Landsat satellite series to map the historical occurrence of flood waters and their dynamics in time and space from the mid-1980s to present. Applying data fusion to two MODIS image products, Rao et al. [13] also analyzed the dynamic change in surface waters in the Yangtze River basin. Looking at the lifespan of the upcoming Surface Water Ocean Topography (SWOT) satellite mission that was dedicated to surface water hydrology, Domeneghetti et al. [14] examined the potential of constructing flow duration curves from satellite data and compared the results with those obtained from long-record gauge data.

For improving the modelling and predictions of floods, satellite rainfall measurements can be a valuable source of data. Yoshimoto and Amarnath [15] analyzed the performance of flood inundation modelling using three common satellite rainfall products (PERSIAN, TRMM and GSMaP) for a river basin in eastern Sri Lanka. Furthermore, in a case study in Sri Lanka, Alahacoon et al. [16] combined the trend analysis from gridded observed rainfall data with flood maps derived from satellite SAR and multispectral data to analyze the spatiotemporal patterns of floods. Using satellite TRMM rainfall data, Bhattacharya et al. [17] looked at flood modelling of the sparsely gauged but very large-scale Brahmaputra basin using the HEC-HMS hydrological model. Complementing TRMM rainfall with data from the Gravity Recovery and Climate Experiment (GRACE) satellite mission, Sun et al. [18] used an index for flood potential to generate monthly terrestrial water storage anomalies in order to better understand the parameters affecting the hydrological state of the Yangtze River basin.

The variety of high-quality research and application studies published in this Special Issue is large and we only provided a brief overview. Therefore, we encourage the reader to refer to the entire Special Issue to gain insight into the current state-of-the-art methods employed in remote sensing for flood monitoring and mapping.

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