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Editorial

Applications of Photogrammetry for Environmental Research

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The applications of photogrammetry for environmental research benefits from the continuous and rapid evolution of sensors and methodologies in this field. The support of photogrammetric tools to a very wide range of research activities was previously confined to geomatic disciplines and the methodologies strictly based on terrestrial or traditional aerial photogrammetry. However, the timely investigation of natural or anthropogenic phenomena required more flexible tools and the ability of geoscientists and researchers involved in the study of natural resources to exploit photogrammetric methodologies in a more flexible way. In the last decade, new opportunities came from the possibility to acquire images using low-cost non-metric cameras from low-altitude unmanned aerial vehicles (UAVs), or fixed locations in terrestrial surveys, with a successive highly automated processing strategy. For instance, a huge amount of papers in the recent scientific literature refers to the structure from motion (SfM) technology in the reconstruction of three-dimensional features at very high spatial and temporal resolutions and with a surprisingly high positional accuracy. Point clouds obtained from best practices in novel approaches of close-range photogrammetry has proven to be of compatible spatial resolution and accuracy of those provided by terrestrial laser scanning and, very often, photogrammetry and laser scanning are combined to enhance the qualities of each other.

However, a limited number of papers were focused on ongoing processes, dynamic assessments or used in modeling of complex phenomena starting from single or repeated photogrammetric surveys with careful design of the timing of investigations. The Special Issue aimed for papers including novelties and advances on the use of recent photogrammetric approaches to a wide range of environmental studies, including the following: photogrammetry for monitoring; UAV photogrammetry for environmental research; photogrammetry for disaster prevention and management; photogrammetry for real-time mapping; merging of data from different survey technologies; and novel uses of proximity surveys to geography, geomorphology, geotechnologies, landscape description, coastal studies, archaeology, etc. Manuscripts on multitemporal investigation of environmental processes by the combined use of photogrammetry and other different technologies were also welcome for this Special Issue. After the revision procedure, seven papers strongly focused on the abovementioned topics have been selected and published. Two of them refer to applications on coastal monitoring using multitemporal images acquired from aerial, satellite and unmanned aerial vehicle platforms. Nikolakopoulos et al. [1] used Pleiades remote sensing data and aerial photogrammetry to quantify the historical rate of coastal erosion in the southwestern Lefkada (Ionian Sea, Greece) coastline. The paper by Jaud et al. [2] describes the activities of the monitoring of Porsmilin Beach (Brittany, France), carried out since 2006 and based on drone photogrammetry; storm impacts and beach resilience have been assessed by a long-term time series of UAV images acquired along a period characterized by multiple technological evolutions. Such a paper faced issues related to data quality/consistency and the need of high accuracy in the generation of digital elevation models (DEM) and orthophotos for coastal hazard purposes. Other papers focused on topics related to investigations on geomorphological hazard: Robiati et al. [3] proposed an application about the use of aerial LiDAR (Light Detection and Ranging) and photogrammetric campaigns to evaluate and

back-analyze the rockfall potential, over almost a decade, in an active quarry located in Cornwall, UK. A methodology to characterize the orientation of discontinuities present within the rock slope is discussed and evidences for potential rockfall evolution were also addressed. The authors presented the use of aerial and terrestrial LiDAR data for the reconstruction of fine surface topography, rock slope kinematic analysis and rockfall trajectory modelling by using both 2D and 3D numerical simulations. Rockfall events have been investigated also by Vanneschi et al. [4]. This paper discusses the ability of the structure from motion (SfM) technique and multi view stereo (MVS) photogrammetry to perform rockfall analyses and hazard assessments. The case study is represented by the Ancient Roman Via Flaminia Road at the Furlo Gorge (Italy). In this paper, traditional geological methods of engineering geology have been combined with terrestrial laser scanning and drone-based digital photogrammetry for successive rock slope stability analyses and 3D rockfall runout simulations. Results show the rockfall hazard in the study area bring into evidence the fundamental role of detailed photogrammetric surface models in the reconstruction of slope, joints and block geometries. Moreover, this Special Issue includes a paper by Urban et al. [5] that deals with the prediction of landslides supported by UAV photogrammetry and laser scanning in mountainous environments (Malá Studená Dolina, Little Cold Valley, High Tatras National Park, Slovakia). The authors discuss logistic constraints, methodologies and accuracy achieved in the 3D reconstruction of talus cones in mountainous terrain hosting seasonal, heavy-used hiking trails. Finally, Liu et al. [6] present a paper on the application of satellite-based photogrammetry to map canopy heights of poplar plantations in plain areas (Horqin Sandy Land, eastern Inner Mongolia, China). In particular, the canopy heights have been mapped through a combination of stereo and multispectral data provided by China's latest civilian stereo mapping satellite ZY3-02.

In addition to such research papers, a review by Stead et al. [7] on the application of remote sensing to the investigation of rock slopes is included in the Special Issues. In such a review, the authors discuss a range of applications of field and remote sensing approaches for the characterization of rock slopes at various scales and distances and highlight advantages and limitations of the methodologies nowadays available in the accurate 3D representation of rock slopes.

The editors hope that the scientific community involved in photogrammetry and remote sensing for environmental applications will find the papers published in this Special Issue useful for their future investigations in a similar field.

References

1. Nikolakopoulos, K.; Kyriou, A.; Koukouvelas, I.; Zygouri, V.; Apostolopoulos, D. Combination of Aerial, Satellite, and UAV Photogrammetry for Mapping the Diachronic Coastline Evolution: The Case of Lefkada Island. *ISPRS Int. J. Geo-Inf.* **2019**, *8*, 489.
2. Jaud, M.; Delacourt, C.; Le Dantec, N.; Allemand, P.; Ammann, J.; Grandjean, P.; Nouaille, H.; Prunier, C.; Cuq, V.; Augereau, E.; et al. Diachronic UAV Photogrammetry of a Sandy Beach in Brittany (France) for a Long-Term Coastal Observatory. *ISPRS Int. J. Geo-Inf.* **2019**, *8*, 267.
3. Robiati, C.; Eyre, M.; Vanneschi, C.; Francioni, M.; Venn, A.; Coggan, J. Application of Remote Sensing Data for Evaluation of Rockfall Potential within a Quarry Slope. *ISPRS Int. J. Geo-Inf.* **2019**, *8*, 367.
4. Vanneschi, C.; Di Camillo, M.; Aiello, E.; Bonciani, F.; Salvini, R. SfM-MVS Photogrammetry for Rockfall Analysis and Hazard Assessment Along the Ancient Roman Via Flaminia Road at the Furlo Gorge (Italy). *ISPRS Int. J. Geo-Inf.* **2019**, *8*, 325.
5. Urban, R.; Štroner, M.; Blistan, P.; Kovanič, Ľ.; Patera, M.; Jacko, S.; Ďuriška, I.; Kelemen, M.; Szabo, S. The Suitability of UAS for Mass Movement Monitoring Caused by Torrential Rainfall—A Study on the Talus Cones in the Alpine Terrain in High Tatras, Slovakia. *ISPRS Int. J. Geo-Inf.* **2019**, *8*, 317.

6. Liu, M.; Cao, C.; Chen, W.; Wang, X. Mapping Canopy Heights of Poplar Plantations in Plain Areas Using ZY3-02 Stereo and Multispectral Data. *ISPRS Int. J. Geo-Inf.* **2019**, *8*, 106.
7. Stead, D.; Donati, D.; Wolter, A.; Sturzenegger, M. Application of Remote Sensing to the Investigation of Rock Slopes: Experience Gained and Lessons Learned. *ISPRS Int. J. Geo-Inf.* **2019**, *8*, 296.