remote sensing

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Editorial

Remote Sensing and GIS for Environmental Analysis and Cultural Heritage

Tomasz Noszczyk [1,*] and Pelagia Gawronek [2]

[1] Department of Land Management and Landscape Architecture, Faculty of Environmental Engineering and Land Surveying, University of Agriculture in Krakow, 253c Balicka Street, 30-149 Krakow, Poland
[2] Department of Land Surveying, Faculty of Environmental Engineering and Land Surveying, University of Agriculture in Krakow, 253a Balicka Street, 30-149 Krakow, Poland; p.gawronek@ur.krakow.pl
* Correspondence: tomasz.noszczyk@urk.edu.pl

Received: 24 November 2020; Accepted: 29 November 2020; Published: 3 December 2020

Dynamically growing remote sensing and geographic information system (GIS) technologies are gaining popularity all over the world as tools for environmental analysis [1–3]. Remote sensing additionally provides data for mapping the surface of the Earth [4,5], identification of landslides [6], and environmental monitoring [7–9]. Moreover, in the time of widespread digitalisation, the domain of remote sensing methods and IT systems that support environmental analysis and cultural heritage decision-making is an important player. 2018 was the European Year of Cultural Heritage. It was an opportunity for numerous initiatives and events all over Europe aimed at bringing cultural heritage closer to the public and encouraging people to improve their involvement in the protection of the heritage. All this led to the initiation of the Remote Sensing Special Issue in 2019, *Remote Sensing and GIS for Environmental Analysis and Cultural Heritage*.

The popularity of application of wide- and close-range remote sensing and GIS tools in such domains as spatial modelling and planning, spatiotemporal analysis, urban analysis, land change science or surveying engineering was reflected in the number of published related articles. This hypothesis was verified with two search queries in the general search interface of the Web of Science Core Collection:

1. We searched for 'remote sensing' and terms such as spatial modelling and planning, spatiotemporal analysis, urban analysis, land change and surveying engineering, occurring together in titles, abstracts, or keywords;
2. We searched for 'wide- and close-range remote sensing' and each of the following terms: Spatial modelling and planning, spatiotemporal analysis, urban analysis, land change and surveying engineering, occurring together in titles, abstracts, or keywords.

The results of the queries are presented in Table 1.

Table 1. The number of related papers following the query (on 19 November 2020).

	Keywords				
	spatial modelling and planning	spatiotemporal analysis	urban analysis	land change	surveying engineering
remote sensing	1448	1046	4323	12,721	322
wide- and close-range remote sensing	4	1	2	7	1

The popularity and continuous development of remote sensing and GIS for environmental analysis and cultural heritage are driven by the prevalence of the Big Data approach today [10]. Remote sensing

data and databases meet the 3Vs requirements for Big Data regardless of their sources, Volume, Velocity, and Variety [11]. 3Vs of remote sensing data and GIS databases guarantee that they are up to date and available. The potential of the data for environmental analysis and cultural heritage is evident from the know-how related to their analysis and processing to extract such pieces of information that can solve specific research problems.

In light of the characteristics and availability of remote-sensing data and the capabilities of GIS tools, this Special Issue proposes 20 different research projects focusing on the theory and practice of the application of modern technologies in environmental and cultural heritage studies (Figure 1).

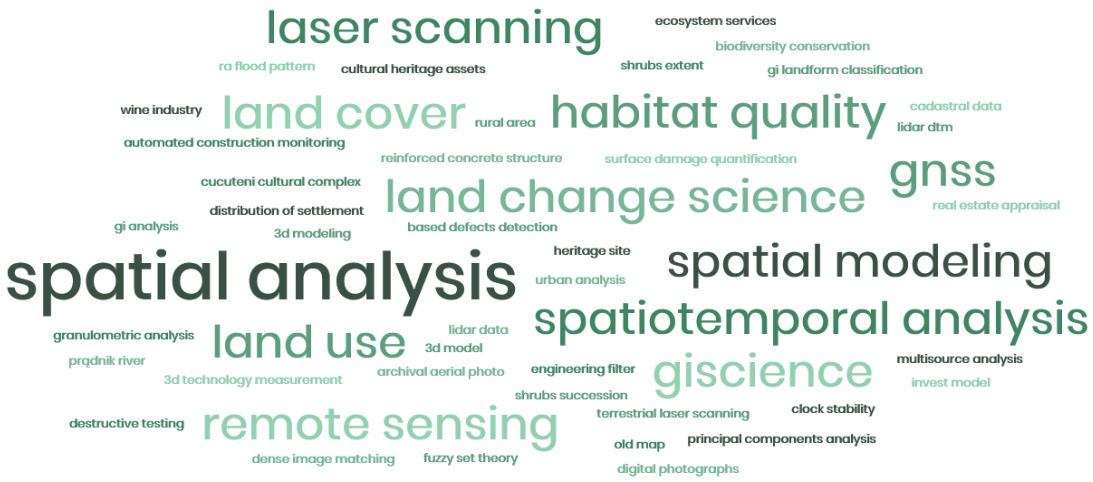

Figure 1. A word cloud generated from 20 publications published in the Special Issue on Remote Sensing and GIS for Environmental Analysis and Cultural Heritage in Remote Sensing.

The environmental and cultural heritage studies published in the Special Issue focus mostly (in 25%) on the synergy of historical materials and modern data [12–16]. Historical maps of settlements and archaeological sites [12,16], economic and cadastral maps [15,16], and aerial orthophotos [13–15] digitised into rasters or point clouds underwent spatial analyses, usually together with LiDAR data. Authors of papers on historical sites [12,15] and spatial development (of forest, rivers, etc.) [13,14,16] employed such digital photogrammetry tools as Canopy Height Model (CHM) from a point cloud [14], Photogrammetry Archive Point Cloud (PAPC) [13], and classification of the standard deviation (SD) of Topographic Position Index (TPI) for the mean elevation (DEV) [12].

Close-range [17–19] and wide-range [20,21] remote sensing data use was presented in 25% of the contributions to the Special Issue. Many of them involved the application of terrestrial laser scanning data [17–19]. In addition, 3D terrestrial laser scanning data were employed to define an original method for automatic detection of damage to continuous surfaces of engineering structures [17], coastal cliff stability analysis [19], or as a basis for determining the geometry of heritage underground structures as part of the development of a 3D cadastre [18]. Wide-range remote sensing projects focused on the classification and texture analysis of satellite imagery for effective investigation of land use [20] and drone-acquired thermal data in the form of near-infrared (NIR) imagery for archaeological investigations [21].

The other papers involved the application of GIS tools for environmental analysis, except for one that focused on methods for the averaging time in high-rate monitoring of satellites [22]. Applications of the information system included mostly the collection, processing, and visualisation of LiDAR data, digital photogrammetry, and topographic and cadastral data. The methodological know-how for GIS analyses included fuzzy theory and fuzzy logic [23,24], the InVEST habitat quality model [25,26], Voronoi diagrams [27], synchronisation algorithms [28], machine learning methods [29], and Ward's method [30]. GIS tools for environmental analysis were employed to investigate habitat

quality [26], topography (altitude of mountain peaks [31], slope aspect [24]), urbanisation [23,25,30], buildings [27,29], or roads [28].

The integration of remote sensing, GIS, and modelling can provide valuable support for management and decision-making. Close-range remote sensing is a means for obtaining comprehensive and detailed spatial data of strategic objects and cultural heritage. Moreover, LiDAR technologies are advancing rapidly, and future developments will have a significant impact on the types of data that will become available in the next decade for remote sensing applications.

Authors were asked to contribute to this Special Issue papers on the application of remote sensing or GIS in such domains as spatial modelling and planning, spatiotemporal analysis, urban analysis, land change science, or surveying engineering. The Special Issue was created in February 2019 and closed on 30 June 2020. Twenty research papers were published over this period following a strict review process.

We hope that this special issue will stimulate further discussion on the real potential of remote sensing and GIS in estimating the status of the environment, its change, and cultural heritage.

Funding: Linguistic support was financed by the Ministry of Science and Higher Education, Republic of Poland [grant number A304/KGPiAK/2019].

Acknowledgments: We are proud to have been entrusted with the roles of Guest Editors and we are immensely grateful to the reviewers who helped us to guarantee the robust scientific value of all the published papers. The work is a result of scientific effort at the University of Agriculture in Krakow, Poland.

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

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