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Editorial

Editorial on Special Issue "Geo-Information Technology and Its Applications"

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Abstract: Geo-information technology plays a critical role in urban planning and management, land resource quantification, natural disaster risk and damage assessment, smart city development, land cover change modeling and touristic flow management. In particular, the development of big data mining and machine learning techniques (including deep learning) in recent years has expanded the potential applications of geo-information technology and promoted innovation in approaches to mining in different fields. In this context, the International Conference on Geo-Information Technology and its Applications (ICGITA 2019) was held in Nanchang, Jiangxi, China, 11–13 October 2019, co-organized by the Key Laboratory of Digital Land and Resources, East China University of Technology, the Institute of Remote Sensing and Digital Earth (RADI) of the Chinese Academy of Sciences (CAS), which was renamed in 2017 the Aerospace Information Research Institute (AIR), CAS, and the Institute of Space and Earth Information Science of the Chinese University of Hong Kong. The outstanding papers presented at this event and some other original articles were collected and published in this Special Issue "Geo-Information Technology and Its Applications" in the *International Journal of Geo-Information*. This Special Issue consists of 14 high-quality and innovative articles that explore and discuss the typical applications of geo-information technology in the above-mentioned domains.

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1. Urban Planning and Infrastructure Optimization

In the field of urban planning and optimal service management, applications of geo-information technology are manifested in aiding analysis and decision-making, information collection and database building, simulation, and forecasting to promote scientific planning. Six articles on GIS-based spatiotemporal big data and related modeling to assist urban infrastructure site selection, assess urban economic development and housing price, and characterize green spaces are published in this section. The first one is the research by Zheng et al. [1] on the boundary of the suitable area based on point of interest (POI) data to obtain the location of parcel-pickup lockers (PPLs). Their research includes construction of a bivariate logistic regression (LR) model to solve the suitability classification problem and training the dataset to filter the critical factors affecting the site selection. Testing results showed that the best LR model had excellent performance, and an optimal solution was obtained for Guangzhou (GZ), China. The findings of the study can assist planning managers in using the suitable areas as the site-selection ranges for PPLs, reducing the difficulties and time costs of analysis.

Spatiotemporal big data can provide new technical methods and data sources for the planning and layout of urban emergency service facilities. For emergency and fire services, which exhibit random occurrence and extremely time-consuming requirements, the theories and methods for studying the spatial and temporal characteristics of the event occurrence and the scientific layout based on spatiotemporal big data have become emerging research fields in recent years. Taking Nanjing as an example, the second and third articles by Han et al. [2,3] used multi-source big data, including ambulance-carried GPS data, Amap-recorded traffic congestion data, and survey data of emergency rescue facilities to study the layout of pre-hospital emergency points and fire stations. In the case of siting emergency stations, the Location Set Covering model was chosen to integrate first aid demands with traffic states, reducing the negative impacts of the random occurrence of demand in space and traffic delays on the planning of pre-hospital emergency stations, and also improving the accuracy of the emergency location model. Doing so also improves the accuracy of the Emergency Medical Services (EMS) siting model, satisfying both the planning conditions and the actual traffic constraints by randomly simulating how the EMS demand can be reached within the target time. Various required factors are determined based on modeling and analysis by processing and analyzing the current data, agreeing on a target time. Calculation of the in-transit time from a large number of randomly distributed EMS simulation points to a facility point may shed light on the model conditions and find solutions for the locations. The frequent occurrence of fires has brought new challenges to urban fire safety, and the spatial layout of fire stations is crucial to firefighting security. In the siting of fire stations [3], multi-source big data, including the full data of the fire outbreak history in the past five years, were collected for a comprehensive analysis. Based on a set of preprocessing tasks—e.g., analyzing the regularity of fire occurrence, selecting the factors related to fire risks, assigning weights to the indicators using the entropy weighting approach, and assessing the risk sore for each single grid—the spatial distribution probability at points in each cluster was calculated according to the clustering analysis, and the random fire outbreak points were generated via Monte Carlo simulation. The travel time from massive randomly distributed simulated fire points to the candidate facility was calculated to obtain the site location. This type of approach incorporates a spatiotemporal big data perspective and provides ideas for improving the siting model and efficiency of emergency site planning.

The fourth paper, by Liu et al. (2020a) [4], took advantage of the OpenStreetMap (OSM) data to evaluate the economic development of cities in China, and the authors found that there is a significant correlation between the OSM road network density and the municipal gross domestic product (GDP). Hence, OSM road network density can be used as a spatial metric to evaluate and forecast the urban economic development in China and possibly also in other countries.

The role of spatiotemporal big data in urban planning is also reflected in the provision of information and services for policy decisions and the public. To assess the impact of urban environmental elements on housing prices, Chen, L. et al. [5] obtained street-view data and high-resolution remote sensing data of Shanghai and calculated the green view index, sky view index, urban green coverage rate, etc. The study also extracted house price data and used the Shapley Additive Explanation (SHAP) method to explain the impact of housing prices. The results show significant differences in the effects of urban greenery coverage and greenery view index on house prices as home buyers in Shanghai are only willing to pay the premium for greenery view houses when the greenery view index or urban greenery coverage is high. The sky visibility index has a negative effect on house prices, probably due to the fact that high-density and high-rise residential areas tend to have better amenities, and residents are more willing to pay the premium for houses in neighborhoods with more water coverage. This study provides a modeling tool to reveal the decisions by homebuyers and property developers and to provide policy support for urban land sales, property development and urban environmental improvements [5].

To provide useful insights for configuring urban greenspace, the sixth paper, by Zhao et al. [6], employed the geographic detector to investigate the spatial distribution of urban forest biomass and the impacts of four potential geographical factors (GFs) on the aboveground biomass distribution of urban forests in 1480 plots in Xi’an, China. The results indicate that the aboveground biomass and four GFs show obvious heterogeneity regarding their spatial distribution, and the interactions among these four GFs also tend to contribute to the distribution pattern of aboveground biomass. Their research reveals that the approach of using geographical detector is a useful tool in the urban area and is able to demonstrate the driving pattern of aboveground biomass and provide a reference for urban planning and management.

2. Land Cover Change Analysis

The application of geo-information technology is able to effectively address the challenges of monitoring land use change dynamics on a large scale. Islands, as peripheral and ultra-peripheral areas, are often highlighted as areas that are ecologically sensitive to human activities as the latter may provoke biodiversity and habitat loss. Hence, understanding land use dynamics and trends in island areas and super-peripheries is essential to maintaining the regional sustainability. Castanho et al. [7] analyzed the trends and dynamics of land use change in the European Archipelagos of the Macaronesia Region (EAR) from 1990 to 2018 based on CORINE data. The study found significant changes in landscape and the need for measures to be taken to mitigate negative environmental impacts. Another article by Wang et al. [8] in this special section, also based on remote sensing data, observed the spatiotemporal variation in vegetation in the source region of the Yellow River (SRYR) during the vegetation growing season. The paper investigates the changes in SRYR using the normalized vegetation index (NDVI) and its response to climate change during the growing seasons of 1998–2016 in combination with climate data based on trend analysis, the Mann–Kendall trend test, and partial correlation analysis. Finally, an NDVI–climate mathematical model was developed to project NDVI trends from 2020 to 2038, reflecting long-term vegetation trends through the past and future variations in vegetation.

3. Poverty Assessment

The extraction of geographical features from remote sensing data is a novel breakthrough in research focusing on social issues. As an objective social phenomenon, poverty has always accompanied the changes in human society and is a long-term problem that hinders the development of human civilization. Based on the Random Forest machine learning method, Yin et al. [9] extracted 23 spatial features based on nighttime lights and geographical data, and they conducted a poverty assessment for Guizhou Province, China, for the period 2012–2019. The authors found that when poor counties are in close proximity to non-poor countries, it makes it easier to eradicate their poverty. This conclusion provides a reference for the identification of poor counties using remote sensing imagery and for research on the potential management of poverty eradication.

4. Geohazard Prediction and Mapping

Geo-information technology is indispensable for georisk analysis and assessment of natural hazards. Geodisaster risk prediction and early warning may serve for decision-making on risk prevention and is the basis for urban safety and protection of human well-being. The paper by Zhang et al. [10] took Guixi County in eastern Jiangxi Province as an example and conducted a landslide risk prediction and zoning study. A comprehensive dataset of 21 geo-information layers, including lithology, faults, rainfall, altitude, slope, distances to faults, roads and rivers, and thickness of the weathering crust, was prepared after assigning weights to the geo-environmental factors based on their landslide propensity. Landslide locations and non-risk zones (mostly flat areas) were vectorized into polygons and randomly divided into two groups to create a training set (70%) and a validation set (30%). With this training set, landslide risk modeling and prediction assessment were achieved using the Random Forest (RF) algorithm, and the validation showed a high reliability of the risk prediction (91.23%).

5. Unmanned Aerial Vehicle (UAV) Application

In the domain of environmental monitoring, the UAV market is expanding at an extremely high rate, and various new UAV technologies are emerging. The gradual maturation of geo-information technology and faster data acquisition will enable UAV applications in environmental monitoring and mapping with higher timeliness. Chen, T. et al. [11] proposed a low-cost UAV photogrammetry point cloud method that can effectively recognize the signatures of revetment damage. In order to recover the finely detailed surface of a revetment in a quick and accurate manner, an object-based dense matching approach was used to generate pixel-by-pixel dense point clouds for characterizing the signatures of revetment damage. Extraction of the damaged areas with different sizes in the slope intensity image of the revetment was effectuated through damage identification using a self-adaptive and multiscale gradient operator in the slope intensity image of the revetment. A revetment with slope protection along urban rivers was selected to evaluate the performance of damage recognition. The results demonstrated that the method could not only restore the fine features of the embankment surface but also significantly improve the accuracy of the damage recognition.

6. Algorithm Improvement

Studies have also explored algorithmic improvements such as the paper by Liu et al. (2020b) [12], who addressed the problem that the Douglas–Peucker (D–P) algorithm is prone to self-intersection and other errors when compressing more complex curves, and this hinders its application in data compression. A new vector line simplification algorithm based on the D–P algorithm, monotonic chains, and dichotomy was hence proposed. The method first used the D–P algorithm to compress complex curves and divided these curves into a number of monotonic chains; second, it applied the dichotomy approach to quickly and precisely locate and process the intersecting monotonic chains so as to solve the self-intersection problem. The improved D–P algorithm was experimentally verified, showing better results in terms of algorithmic efficiency, compression rate, and algorithmic accuracy when dealing with self-intersection problems in vector data compression. Guo et al. [13] proposed a new convolutional neural network for speed segmentation, i.e., the multi-scale water body extraction network (MWEN), and for the automatic extraction of water bodies from the Gaofen-1 satellite images. Three convolutional neural networks, including the fully convolutional network (FCN), Unet, and Deeplab V3+, for semantic segmentation were used to compare the performance of MWEN for water body extraction and visual comparison and five evaluation metrics were harnessed for this purpose. The results illustrate that the improved algorithm produced better extraction than others and has great potential for mapping different types of water bodies with reduced noise.

7. Touristic Management

Li et al. [14] presented a tourist flow forecasting method based on seasonal clustering. The K-means algorithm and the particle swarm optimization least squares support vector machine (PSO-LSSVM) algorithm, which took seasonal variations into account, were used to forecast the tourist flow in the scenic area. The LSSVM was also applied to compare the performance of the proposed model with that of the existing ones. Experiments based on a dataset comprising the daily tourist data for the Huangshan Mountains during the period between 2014 and 2017 were effectuated. Results showed that seasonal clustering is an effective approach to improve tourist flow prediction and management.

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References

1. Zheng, Z.; Morimoto, T.; Murayama, Y. A GIS-Based Bivariate Logistic Regression Model for the Site-Suitability Analysis of Parcel-Pickup Lockers: A Case Study of Guangzhou, China. *ISPRS Int. J. Geo-Inf.* **2021**, *10*, 648. [CrossRef]
2. Han, B.; Hu, M.; Wang, J. Site Selection for Pre-Hospital Emergency Stations Based on the Actual Spatiotemporal Demand: A Case Study of Nanjing City, China. *ISPRS Int. J. Geo-Inf.* **2020**, *9*, 559. [CrossRef]
3. Han, B.; Hu, M.; Zheng, J.; Tang, T. Site Selection of Fire Stations in Large Cities Based on Actual Spatiotemporal Demands: A Case Study of Nanjing City. *ISPRS Int. J. Geo-Inf.* **2021**, *10*, 542. [CrossRef]
4. Liu, B.; Shi, Y.; Li, D.-J.; Wang, Y.-D.; Fernandez, G.; Tsou, M.-H. An Economic Development Evaluation Based on the OpenStreetMap Road Network Density: The Case Study of 85 Cities in China. *ISPRS Int. J. Geo-Inf.* **2020**, *9*, 517. [CrossRef]
5. Chen, L.; Yao, X.; Liu, Y.; Zhu, Y.; Chen, W.; Zhao, X.; Chi, T. Measuring Impacts of Urban Environmental Elements on Housing Prices Based on Multisource Data—A Case Study of Shanghai, China. *ISPRS Int. J. Geo-Inf.* **2020**, *9*, 106. [CrossRef]
6. Zhao, X.; Liu, J.; Hao, H.; Yang, Y. Quantifying the Spatial Heterogeneity and Driving Factors of Aboveground Forest Biomass in the Urban Area of Xi'an, China. *ISPRS Int. J. Geo-Inf.* **2020**, *9*, 744. [CrossRef]
7. Castanho, R.A.; Naranjo Gomez, J.M.; Vulevic, A.; Couto, G. The Land-Use Change Dynamics Based on the CORINE Data in the Period 1990–2018 in the European Archipelagos of the Macaronesia Region: Azores, Canary Islands, and Madeira. *ISPRS Int. J. Geo-Inf.* **2021**, *10*, 342. [CrossRef]
8. Wang, M.; Fu, J.; Wu, Z.; Pang, Z. Spatiotemporal Variation of NDVI in the Vegetation Growing Season in the Source Region of the Yellow River, China. *ISPRS Int. J. Geo-Inf.* **2020**, *9*, 282. [CrossRef]
9. Yin, J.; Qiu, Y.; Zhang, B. Identification of Poverty Areas by Remote Sensing and Machine Learning: A Case Study in Guizhou, Southwest China. *ISPRS Int. J. Geo-Inf.* **2021**, *10*, 11. [CrossRef]
10. Zhang, Y.; Wu, W.; Qin, Y.; Lin, Z.; Zhang, G.; Chen, R.; Song, Y.; Lang, T.; Zhou, X.; Huangfu, W.; et al. Mapping Landslide Hazard Risk Using Random Forest Algorithm in Guixi, Jiangxi, China. *ISPRS Int. J. Geo-Inf.* **2020**, *9*, 695. [CrossRef]
11. Chen, T.; He, H.; Li, D.; An, P.; Hui, Z. Damage Signature Generation of Revetment Surface along Urban Rivers Using UAV-Based Mapping. *ISPRS Int. J. Geo-Inf.* **2020**, *9*, 283. [CrossRef]
12. Liu, B.; Liu, X.; Li, D.; Shi, Y.; Fernandez, G.; Wang, Y. A Vector Line Simplification Algorithm Based on the Douglas–Peucker Algorithm, Monotonic Chains and Dichotomy. *ISPRS Int. J. Geo-Inf.* **2020b**, *9*, 251. [CrossRef]
13. Guo, H.; He, G.; Jiang, W.; Yin, R.; Yan, L.; Leng, W. A Multi-Scale Water Extraction Convolutional Neural Network (MWEN) Method for GaoFen-1 Remote Sensing Images. *ISPRS Int. J. Geo-Inf.* **2020**, *9*, 189. [CrossRef]
14. Li, K.; Liang, C.; Lu, W.; Li, C.; Zhao, S.; Wang, B. Forecasting of Short-Term Daily Tourist Flow Based on Seasonal Clustering Method and PSO-LSSVM. *ISPRS Int. J. Geo-Inf.* **2020**, *9*, 676. [CrossRef]