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Editorial: Advances in GIS and remote sensing the landscape pattern of land cover on urban climate and urban ecology

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Editorial on the Research Topic
Advances in GIS and remote sensing the landscape pattern of land cover on urban climate and urban ecology

Globally, more than half of the urban population is facing severe social-economic and ecological challenges. These challenges are especially those relating to growing urban heat islands, land cover conversions, land encroachment, informal settlements, traffic congestion, land and water pollution (Ye and Pei), decline in landscape connectivity, green infrastructure fragmentation, soil erosion (Singh et al.) and environmental degradation, due to rapid urban expansion. These changes affect urban climate and landscape ecology, thereby compromising the provision of ecosystem services and human livelihoods. Advances in Geographic Information Systems (GIS), Remote Sensing technologies and other robust spatial analytical and quantitative methods are urgently and routinely required in managing these socio-economic and environmental challenges.

Existing, new sources of data (i.e., OpenStreetMap road network data) (Wu et al.), emerging and advanced Geospatial Information Systems technologies and remote sensing offer great opportunities to acquire ubiquitous spatial data over time and space. These approaches enable the monitoring and detection of the spatial-temporal patterns of changes in the landscape and urban climate at various spatial and temporal scale, as well as to make predictions and scenarios for future landscape ecology and urban surface temperature trends. Containing contributions from various researchers and experts around the world based on a collection of original research articles, this Research Topic documents the Remote Sensing and GIS applications in tackling the challenges of urban climate and landscape ecology research from local scale (urban, suburban areas, urban fringes) to national spatial scales, but with more focus on urban areas.

Furthermore, the Research Topic showcases the applications of various remote sensing data and Geospatial techniques including Landscape metrics (Spatial metrics), Geodetector, Machine Learning (ML), Spatial Autocorrelation Methods (Global Moran I and Local Indicator of Spatial Association (LISA) of local Moran's index and Hot Spot Analysis tool (Getis-Ord Gi*)), Landscape Ecological Risk, Nearest Neighbor Index (NNI) and Kernel Density analytical techniques. Over the years, Landscape metrics have been widely used for generating fragmentation metrics using categorical land cover maps derived from classified remote sensing data for quantifying landscape structure and composition. Their application has been largely due to their effectiveness as evidenced in previous work in relating them to underlying biophysical or ecological processes. Spatial Metrics combined with GIS have proved to be useful technologies in spatial and temporal mapping and analysis of landscape fragmentation, urban sprawl, agglomeration, and different morphological aspects of urban growth patterns (Gupta et al.).

In this Research Topic, Geodetector tools have been demonstrated as vital tools in analysing the relationship between landscape pattern and factors influencing landscape ecological risks in city suburbs (Cheng et al.) and coastal estuarine tidal flats (Li et al.). The tools were also able to detect spatial heterogeneity and influencing factors of High-Level Tourist Attractions (HLTAs) (Shu et al.). Similarly, in landscape ecology, second-order statistics have emerged as important tools in assessing spatial autocorrelation of landscape ecological risks (LER) and HLTAs at a global and local scale by employing the Global Moran's I, local Moran's index, and Hot Spot Analysis tool (Getis-Ord Gi*) methods (Cheng et al.; Shu et al.). However, as demonstrated by Shu et al. within the Yellow River Basin in China, the integration of spatial autocorrelation indices with other techniques, such as the Nearest Neighbour Index (NNI) and Kernel density, is crucial for accurately estimating and visualizing the spatial distribution and agglomeration patterns of High-Level Tourist Attractions.

There is also a growing concern over significant land cover changes and unplanned urban expansion (urban sprawl, which usually displaces natural areas with impervious and built-up areas). These changes are responsible for inducing the sensible heat rather than latent heat thereby increasing land surface temperature and affecting the urban thermal environment (Gupta et al.; Mehmood et al.; Rahman et al). With the advancement in Artificial Intelligence (AI) and Machine Learning (ML)-based modelling techniques and approaches such as Support Vector Machine (SVM), Gradient Boosting (GB), AdaBoosting, and Random Forest (RF), combined with freely available multispectral remote sensing data like Landsat and Sentinel 2, it has become possible to analyse, spatially simulate and predict future land surface temperatures associated with different spatial patterns of land cover (e.g., water, built-up areas, vegetation cover) and land use (e.g., agriculture land, residential, industrial and commercial areas) changes and urban growth patterns with higher accuracy (Mehmood et al.). Furthermore, ML methods can serve as useful tools to evaluate the spatial disorder, a large-scale measurement of different street space health (Wan and Wang).

In addition, in recent years, ML algorithms have become popular in land cover classification (Rahman et al.) because they are powerful, reliable, more adaptable, faster, and less expensive in quantifying and extracting accurate information. Similarly, recent remote sensing studies have showed that the open-source Google Earth Engine (GEE) cloud computing platform is rapidly growing with the use of advanced machine learning algorithms. GEE has shown invaluable capabilities in processing large remote sensing and other spatial datasets for land cover and land use detection and monitoring (Mehmood et al.; Rahman et al.). The GEE renders the much-required long-term time records (i.e., Landsat imagery) and access to advanced machine learning to complement the user training dataset. Rahman et al. employed the RF algorithm in GEE to quantify Land surface temperature using a series of Landsat images. The integration of new and existing datasets remains promising for the geospatial analysis and remote sensing of urban climate and landscape ecology. As highlighted in a study that analysed the impact range of thermal landscape footprint of various types of functional blocks (Wu et al.), the integration of new and existing datasets remains promising for the geospatial analysis and remote sensing of urban climate and landscape ecology. The study used a combination of Landsat 8 remote sensing imagery, OpenStreetMap (OSM) road network data, and kernel density analysis (Wu et al.).

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