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Editorial: Remote sensing advances in biodiversity and ecosystem functioning research

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Editorial on the Research Topic
Remote sensing advances in biodiversity and ecosystem functioning research

1 Introduction

Different dimensions of biodiversity are increasingly appreciated as critical for maintaining the functions of ecosystems and their services to humans. More recently, with the emergence of functional biogeography, functional diversity is of particular interest due to its strong links with ecosystem processes such as carbon, water and energy exchange, and climate mitigation. The multi-form diversity varies in space and time. Understanding this variation across scales is important for tracking the resilience of earth's ecosystem, and the information on the ecosystem structural features provides necessary foundations for monitoring, predicting the ecosystem functioning patterns and process of ecosystems from individual unit to its whole in a holistic manner.

In recent, the high-resolution, high-throughput, non-intrusive, and large-scale data on biodiversity monitoring and measurement are becoming a new trend toward enhancing the efficiency and coherency in ecological discovery. Remote sensing has proved to be a critical technology for addressing this research gap. Air- and satellite-borne spectrometers at different levels could develop novel diversity measurements and alternatives in various ecosystems and for different kinds of communities and taxa.

In this Research Topic, our goal is to bring together the latest research in a fast-growing direction that combines remote sensing techniques and their application in biodiversity and ecosystem functioning (BEF). We would like to know how the different levels of ecological theories, from species to ecosystems, are linked more coherently than ever via the multi-scale digitalized observational and computational method advances. Seen from the 11 published papers in this Research Topic, we generalized the three main directions in this field: (1) the novel observational techniques of biodiversity and their application, (2) the ecosystem functioning assessment at macroscopic scale with geoinformatics methods, and

(3) the linkage analysis of BEF under the geographical gradient of in a context of environmental change.

2 Novel observational techniques of biodiversity

In the realm of novel biodiversity observational techniques, Hagani et al. ‘s research delves into the historical invasion of Phragmites australis in a brackish coastal marsh, utilizing high-resolution remote sensing to meticulously map its expansion over two decades. Despite individual management efforts, Hagani et al. emphasizes the need for adaptive, collaborative strategies to eradicate this invasive species on a large scale.

Shifting focus to subtropical forests, Yan et al. introduces a groundbreaking forest measurement system using SLAM+AR technology through mobile phones. This system not only accurately measures tree parameters but also creates a virtual environment for precise spatial structural analysis, revolutionizing digitalized forest management practices.

Expanding the scope to forest ecosystems, Li et al. pioneers UAV-borne hyperspectral and LiDAR data for individual tree-based species diversity estimation. Li et al. ‘s classification method, relying on spectral information, proves superior in accurately predicting species richness and the Shannon-Wiener index. In contrast, Li et al. ‘s clustering method, while introducing uncertainties, rapidly captures forest diversity patterns without distinguishing specific tree species.

In conclusion, the studies showcase the frontier of biodiversity observation, leveraging remote sensing, mobile technology, and UAV-based approaches. They embody the innovative strides in understanding and managing diverse ecosystems.

3 Large-scale ecosystem functioning assessment

In the realm of large-scale ecosystem functioning assessment, Lu et al. utilizes geographic information systems (GIS) and spatial data to quantitatively study diversity patterns within Moraceae genera. Results reveal significant differences between monotypic and multiple-species genera, emphasizing the importance of spatial distribution analysis for effective conservation strategies.

Zhang et al. ‘s exploration of ecosystem services in Xinjiang Autonomous Region contributes to understanding driving factors and spatial heterogeneity. The study employs InVEST and RWEQ models, identifies precipitation, temperature, and fractional vegetation cover as dominant factors influencing essential ecosystem services. The study’s county-level analysis provides nuanced insights for tailored ecological protection policies.

On the analysis of city level, Wang et al. introduces the application of remote sensing ecological index (RSEI) to monitor ecological environment quality in Zhanjiang City. Utilizing Landsat satellite images and four indicators, the study quantitatively assesses changes in ecological quality over time. The study highlights the effectiveness of RSEI in evaluating and predicting ecological changes, essential for guiding conservation measures in urbanizing areas.

On a larger scale, Wei et al. ‘s study shifts the focus to synergies and trade-offs in ecosystem services within China’s arid regions. Using the northern sand-stabilization belt as a case study, Wei et al. explores how precipitation and fractional vegetation cover influence five simulated ecosystem services. The research uncovers increasing synergies with higher precipitation and vegetation cover, providing valuable insights for sustainable ecosystem management in arid environments.

These findings underscore the importance of spatial analysis, remote sensing technologies, and tailored conservation strategies for effective ecosystem management in diverse environments.

4 BEF under the environmental change

Peng et al. ‘s study on the impact of climate change on plant spectral diversity highlights significant shifts in spatial patterns across various forest types. The intricate relationships between species diversity, spatial interactions, and climate change are emphasized. This insight lays the foundation for understanding the broader implications of environmental changes on biodiversity.

From the forest to the grassland perspective, we delve into Yang et al. ‘s exploration of plant species diversity and aboveground biomass in alpine grasslands on the Qinghai–Tibet Plateau. Through advanced modeling, Yang et al. provides a comprehensive understanding of the spatial relationships and driving factors governing these crucial ecological parameters. This grassland-focused perspective contributes to our knowledge of ecosystem functioning in alpine regions.

Shifting our focus to urban environments, Ma et al. ‘s research investigates the projected effects of climate change and urban expansion on plant biodiversity in the city clusters of Northern China. Employing habitat suitability models, Ma et al.‘s findings underscore the urgency of addressing urban expansion as a primary driver of plant biodiversity loss in this region. The transition from natural to urban landscapes emphasizes the need for sustainable urban planning to mitigate the impact on local ecosystems.

Gao et al. ‘s study on vegetation water use efficiency (WUE) in the West Liao River Plain explores the temporal and spatial variations of WUE in response to climate change and human activities. By unraveling the intricate dynamics between carbon and water cycles, Gao et al.‘s research contributes to our understanding of ecosystem functioning in regions sensitive to environmental changes.

These studies collectively contribute to the understanding of biodiversity and ecosystem functioning under the complex interplay of environmental changes. From grasslands to forests and urban areas, each perspective offers unique insights into the challenges and opportunities for managing and conserving ecosystems in the face of increasing climate change and human activities.

Author contributions

ZL: Funding acquisition, Project administration, Supervision, Writing – original draft, Writing – review & editing. JW: Writing – original draft, Writing – review & editing. SP: Project administration, Writing – original draft, Writing – review & editing. YX: Project administration, Writing – review & editing, Resources. WS: Supervision, Writing – review & editing. JG: Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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