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EDITED AND REVIEWED BY
Angela Helen Arthington,
Griffith University, Australia

*CORRESPONDENCE

Nan Xu,
✉ xunan2025@szu.edu.cn

RECEIVED 22 October 2025

ACCEPTED 23 October 2025

PUBLISHED 07 November 2025

CITATION

Yao J, Yang D, Wang Z and Xu N (2025) Editorial:
Satellite remote sensing for hydrological and
water resource management in coastal zones.
Front. Environ. Sci. 13:1730256.
doi: 10.3389/fenvs.2025.1730256

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Editorial: Satellite remote sensing for hydrological and water resource management in coastal zones

Jiaqi Yao¹, Di Yang^{2,3}, Zhen Wang⁴ and Nan Xu^{5,6*}

¹Academy of Ecological Civilization Development for JING-JIN-JI Megalopolis, Tianjin Normal University, Tianjin, China, ²School of Computing, Wyoming Geographic Information Science Center, University of Wyoming, Laramie, WY, United States, ³Department of Geography, University of Florida, Gainesville, FL, United States, ⁴School of Computer Science, Northwestern Polytechnical University, Xi'an, Shaanxi, China, ⁵Key Laboratory for Geo-Environmental Monitoring of Great Bay Area, Ministry of Natural Resources and Guangdong Key Laboratory of Urban Informatics, Shenzhen University, Shenzhen, China, ⁶School of Architecture and Urban Planning, Shenzhen University, Shenzhen, China

KEYWORDS

remote sensing, coast, water resources management, geography, climate change

Editorial on the Research Topic

Satellite remote sensing for hydrological and water resource management in coastal zones

1 Introduction

Coastal zones concentrate people, economies, and biodiversity yet face mounting pressure from climate change, pollution, and overuse (Jiang et al., 2021; Zhang et al., 2022; Hu et al., 2020). Rising seas, erosion, extreme events, hydrological shifts, and contamination make safeguarding coastal water resources both urgent and complex (Xu and Gong, 2018; Wang et al., 2024; Xu et al., 2022). Satellite remote sensing now offers a step-change in capability: SWOT and Sentinel-6 resolve water-surface elevation, tides, and long-term sea-level signals; Landsat, Sentinel-1, and Sentinel-2 capture shoreline morphology, vegetation, turbidity, and other water-quality proxies. Together these missions deliver consistent, high-resolution observations to diagnose status and trends across dynamic land-ocean interfaces (Yao et al., 2025a). When fused with machine-learning models, they can quantify processes, forecast change, and inform practical decisions—from ecosystem protection and pollution control to sustainable allocation and climate adaptation (Xu et al., 2023; Wu et al., 2023).

Following rigorous peer review, six manuscripts have been selected for publication. These studies encompass urban hydrological modeling, satellite-derived bathymetry, wetland ecosystem assessment, water quality parameter inversion, and hyperspectral image processing, investigating diverse environments from urban campuses and coastal waters to wetland ecosystems and specialized hyperspectral datasets. This Editorial provides an overview of the academic contributions from the six papers.

2 Overview of the published contributions

Ecological and environmental monitoring underpins progress toward sustainability, and the fusion of satellite remote sensing with artificial intelligence is transforming both process understanding and evidence-based management. Against this backdrop, [Tran et al.](#) addressed the long-standing difficulty of estimating chlorophyll-*a* across optically diverse waters—where classic blue/green and red/NIR algorithms often fail—by proposing the CONNECT framework, which first classifies optical water types (OWTs) and then applies matched bio-optical models ([Tran et al.](#)). Their implementation uses two tailored multilayer perceptrons (NN-Clear and NN-Turbid) to capture spectral–biogeochemical relations under contrasting conditions, and benchmarking confirms robust performance for both turbid and clear waters. Complementing this water-quality focus, [Yue et al.](#) evaluated four core ecosystem functions across four wetland nature reserves in Tianjin (2000–2020) with the InVEST model, mapping spatiotemporal dynamics of key ecological drivers and, via an ETSM analysis, quantifying trade-offs and synergies among services ([Yue et al.](#)). They found pronounced functional contrasts among management zones, with core and buffer areas consistently outperforming experimental zones, and complex, period-dependent interactions among services—insights that directly inform zoning and restoration priorities. In a second study, [Yue et al.](#) coupled Land Expansion Analysis Strategy and a Cellular Automata module within the PLUS framework to link remotely sensed land-use change (2000–2020) to socioeconomic and accessibility drivers (population, GDP, road distance). Using an equivalent-factor approach, they estimated ecosystem service value (ESV) and projected its evolution under natural growth, economy-oriented, and eco-protection scenarios, thereby revealing how alternative development pathways reshape wetland services ([Yue et al.](#)). Shifting to coastal bathymetry, [Lu et al.](#) examined how water-quality optical properties modulate the accuracy of satellite laser altimetry in O’ahu’s nearshore waters ([Lu et al.](#)). Working from ICESat-2 ATL03 photons, they extracted valid subsurface returns with an Adaptive Elevation Difference Threshold Algorithm, downscaled MODIS water-quality fields using Random Forest to improve spatial congruence, and derived an empirical link between optical conditions and ICESat-2 depth errors—offering a practical route to error prediction and correction. Finally, to improve urban hydrologic modeling with SWMM, [Yang et al.](#) developed an intelligent calibration pipeline that integrates Latin Hypercube Sampling, Self-Organizing Maps, SA-BP sensitivity analysis, and GLUE uncertainty quantification ([Yang et al.](#)). Applied to two 2023 storm events on the central campus of Jilin University, the approach tightened parameter ranges for nine key variables, reduced predictive uncertainty, identified a 10% imperviousness threshold for runoff-generation regime shifts, and clarified dominant controls across imperviousness scenarios—advancing flood modeling, drainage design, and risk-informed decision-making.

3 Conclusion

The six papers in this Research Topic, “*Satellite Remote Sensing for Hydrological and Water Resource Management in Coastal Zones*,” demonstrate the expanding frontier where satellite observations meet intelligent analytics. Encompassing coastal water-level monitoring, water-quality assessment, wetland ecosystem evaluation, urban hydrology, and nearshore bathymetry, these studies show how multi-mission datasets (SWOT, Sentinel-6, Sentinel-1/2, Landsat), when fused with machine learning and cloud computing, capture land–ocean dynamics, quantify ecosystem services, and strengthen evidence-based water governance. Together, they signal a clear shift: integrated Earth observation and AI are redefining how coastal hydrology is measured, modeled, and managed across scales—from tidal channels to deltaic plains—while improving methodological transparency, comparability, and decision relevance.

Looking ahead, continued gains in spatial–temporal resolution, open data access, and computational capacity will further enhance precision and efficiency. We anticipate physics-informed, uncertainty-aware AI, harmonized cross-sensor data cubes linking altimetry, SAR, optical, and biogeochemical proxies, and near-real-time coastal dashboards that integrate environmental indicators with socio-economic layers ([Xu, 2025](#)). Such advances will enable proactive flood and erosion risk management, targeted pollution control, and adaptive ecosystem restoration ([Yao et al., 2025b](#)). By promoting replicable, scalable, and operational methods, this Research Topic points toward a more resilient future for coastal water resources and accelerates global environmental governance and conservation under climate change and growing human pressures.

Author contributions

JY: Conceptualization, Investigation, Project administration, Writing – original draft. DY: Investigation, Writing – review and editing. ZW: Investigation, Writing – review and editing. NX: Conceptualization, Funding acquisition, Writing – review and editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This work was jointly supported by the Natural Science Foundation of Jiangsu Province (BK20240258) and the Fundamental Research Funds for the Central Universities (B240201032).

Acknowledgements

We deeply thank all the authors and reviewers who have participated in this Research Topic.

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