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Editorial: Assessment and restoration of river ecosystem integrity

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Editorial on the Research Topic
Assessment and restoration of river ecosystem integrity

Rivers serve as vital conduits that connect land and ocean, facilitating the circulation of water and materials. Presently, there are more than 845,000 dams erected along approximately two-thirds of the world's rivers. This extensive damming results in river fragmentation, the creation of reservoirs, sediment deposition in cascade reservoirs, alterations in river flow patterns, as well as shifts in physical and hydrochemical conditions and the habitat for aquatic plants, plankton, and fish. These alterations disrupt processes related to reproduction, recruitment, and biological growth, ultimately impacting the biodiversity and overall integrity of the river ecosystem. When combined with the long-term cumulative effects of climate change, water utilization, river management, and water pollution, the majority of rivers worldwide show declines in ecosystem integrity. However, in many river basins, the absence of data on physicochemical conditions, habitat structure, and biological communities hinders the evaluation of aquatic ecological integrity and the formulation of strategies for biodiversity protection. Addressing the degradation of river ecosystems and developing restoration plans and strategies necessitates commencing with a clear understanding of the ecological status and the primary stressors responsible for the deterioration of river ecosystems. This should be followed by the development of restoration strategies and governance systems that target the predominant issues at appropriate spatial and temporal scales.

Given the challenges posed by considerable temporal and spatial variations, poorly understood degradation mechanisms, and ineffective governance approaches for the management of large river ecosystems, this Research Topic explores scientific techniques for evaluating ecosystem integrity in different types of rivers. It elaborates on the mechanisms and driving forces behind the degradation of river ecosystems and the loss of ecological integrity. Additionally, it reports on new technologies that support river restoration, protection, and management. Our goal is to compile fresh methods, indicators, insights, and case studies for the assessment of river ecosystem integrity, providing a robust scientific foundation for the protection and restoration of biodiversity and ecosystems.

Within this context, this Research Topic has encouraged the academic community to contribute original research aimed at restoring the integrity of river ecosystems. A total of six articles has been gathered, covering various aspects of river water quality and ecosystem integrity. The compiled works primarily address topics such as geochemical cycling, acid mine drainage, carbon dioxide levels and emissions, karst topography, salmonid spawning habitats, macroinvertebrate diversity and fish biotic integrity indices.

Pander et al. have proposed substratum restoration as a means to enhance oxygen availability within groundwater-dominated ditches, suggesting their incorporation into an effective river restoration strategy. They have also explored the contribution of a groundwater-influenced hinterland drainage system to the restoration of salmonid spawning habitats in the upper reaches of the Danube River in Germany. In another study, a novel biological integrity index based on long-term changes in fish assemblages was developed to assess the ecological status of a semi-artificial aquatic ecosystem in the Three Gorges Reservoir. Zhu et al. advocate for biologically integrated management of reservoirs and green sustainable development goals as part of national policies for aquatic ecosystem protection.

Bing et al. have investigated the geochemical cycling of phosphorus and iron in a typical reservoir located in the Xiaoxing'an Mountains of north-eastern China. Their research reveals that dam interception has a significant impact on the bioavailability of phosphorus and iron, thereby enhancing nutrient cycling in the region. This, in turn, affects the bioavailability and cycling of these elements in downstream rivers and, ultimately, in the oceans. In addition, Huang et al. have investigated the buffering of a riverine carbonate system in the presence of acid mine drainage within a small karst watershed in southwest China. Their research indicates that, under current conditions, the Huatan River exhibits CO_2 degassing characteristics during winter and spring. However, as atmospheric CO_2 concentration rises, it is expected to become a sink for atmospheric CO_2. This underscores the increasing importance of the carbon sink effect in karst areas. Bao et al. have examined the carbon dioxide partial pressures and emissions of the Yarlung Tsangpo River on the Tibetan Plateau. Their findings reveal unique characteristics, such as a "weak outgassing effect and a high transport flux of carbon" which distinguish plateau rivers from those on plains. Given the global significance of the Tibetan Plateau, they emphasize the need for further studies with enhanced spatio-temporal resolution to gain a better understanding of the pivotal role played by plateau rivers in carbon budgets and climate change, both regionally and globally.

Finally, Banad et al. have studied the effects of altered streamflow on the taxonomic richness and composition of macroinvertebrates in the Goulburn River of Australia. They highlight the substantial impacts of both river flow regulation and the Millennium Drought on macroinvertebrate communities within the Goulburn Basin. Beyond the immediate implications for this region, their findings hold broader significance for the field of river science and ecosystem management for ecological integrity. By revealing the intricate interplay between hydrological changes, the complexities of flow patterns and ecological responses, their work contributes to a more comprehensive understanding of how human-induced and climatic alterations can shape aquatic ecosystems. Moreover, macroinvertebrate communities, consisting of aquatic insects and other invertebrates, offer valuable insights into ecosystem health. By studying their composition and abundance, we can understand how changes in flow regimes affect aquatic habitats. Incorporating macroinvertebrate data into environmental flow management allows for more precise strategies that consider the specific needs of these communities, ensuring the sustainable health of aquatic ecosystems.

Author contributions

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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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