流域水生态保护与修复的多维视角与差异化策略

Multi-dimensional Perspectives and Differentiated Strategies of Basin-Scale Water Ecological Conservation and Restoration

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摘要

河湖水生态状况事关民生福祉，而流域是开展河湖水生态治理的最佳单元，为准确把握高质量发展阶段下河湖水生态治理的发力点，满足人民日益增长的美好生活需要，需在流域单元下从自然生态系统功能过程、历史、社会人文与艺术等多维视角，对水生态保护与修复进行立体认知，并根据不同区域的自然禀赋、经济条件及文化底蕴等情况采取差异化策略，以生态与文化为双内核，对流域水生态系统演替、水文化形态演进及大地景观格局演变等多个过程进行动态耦合，合理选择流域、区域、河流廊道、河段等作为工作尺度，以达到事半功倍之效。希望藉由本期中流域治理理念指导下的理论研究与实践探索，推动空间规划、水利工程与景观设计等多学科与行业的交流互动，营造安全、洁净、健康、美丽的河湖水系，建设造福人民的幸福河。

关键词

流域；河湖；生态保护与修复；多维视角；差异化策略

ABSTRACT

The status of water ecological environment matters to the well-being of all people. A water ecological management system for high-quality development is required to meet people's ever-growing expectations for a better life. This relies on a comprehensive understanding of water ecosystems from multi-dimensional perspectives—processes of ecosystem services, history, culture, and art—at the basin scale. Moreover, differentiated strategies should be proposed to adjust to varied natural resource endowment, and socio-economic and cultural heritage in different regions. Only by centering on both ecology and culture through multiple processes (e.g., evolution of regional river basin ecosystem, water cultures, and landscape patterns) dynamically under proper scales (basin, region, river corridor, or river reach), can the water ecosystem function more effectively. In this issue, *LA Frontiers* hopes to propel interaction between multiple disciplines and industries among spatial planning, hydraulic engineering, and landscape design with research and practice, so as to ensure a safe, clean, healthy, and picturesque river–lake system for people's well-being.

KEYWORDS

Basins; Rivers and lakes; Ecological Conservation and Restoration; Multidimensional Perspectives; Differentiated Strategies

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天门中断楚江开，碧水东流至此回。
两岸青山相对出，孤帆一片日边来。

——李白《望天门山》

一千多年前，李白孤舟行江顺流而下，长江奔腾东流，气势如虹，江边天门山耸立云霄，舟、水、人动态协调，美不胜收，诗人由衷赞美了大自然的壮丽及其所蕴含的生态之美。从古时诗人对自然的赞美到现代广大人民群众对幸福河的美好向往，都表明了人们对健康水生态亘古不变的期许。

河流生态系统的生态过程可通过系统的结构、功能、景观异质性、缀块性、植被、生物量等因子来评价，这些因子往往与水文因子及水文过程密切相关。同时，生态过程所涉及的范围又常与水文过程的范围相重合——多为流域尺度[1]。因此，流域作为由分水岭分隔而成的空间单元，既是陆地水循环的基本单元，也是生态保护与治理的最佳单元[2]。流域的自然地理、气候、地质和土地利用等要素决定着河流的径流、河道、基质类型、水沙特性等物理及水化学特征，这些因素对河流生态系统均有着深远影响。

但由于缺乏对现代流域开发的科学认知及缺失严格管理制度，中国大河流域的开发正面临严峻挑战[3]。2012年以来，国家提出了建设天蓝、地绿、水清的美丽中国的愿景，按照“节水优先、空间均衡、系统治理、两手发力”的治水思路，大力推进生态文明建设。长江大保护和黄河流域生态高质量发展的国家战略为新时期的中国生态文明建设与发展指引了方向。明确水生态系统保护与修复的概念与内涵、厘清存在的问题、识别问题成因、提出总体思路与关键举措、制定保障措施是新时期水生态系统保护与修复的五个重要方面[4]。为准确把握高质量发展阶段下河湖水生态治理的发力点，应基于流域单元，从自然生态系统功能过程、历史、社会人文与艺术等多维视角，对水生态保护与修复进行立体认知，并根据不同区域的自然禀赋、社会经济及文化底蕴等情况采取差异化策略。

在此背景下，本期邀请世界范围的学者、规划师和设计师共同探讨上述有关流域水生态系统保护与修复的多维视角与差异化策略议题，基于流域单元特征与区域特点，从不同视角突破常规的认知惯性，重新认识受损水生态环境与水文过程的关系。

https://doi.org/10.15302/J-LAF-1-010017
收稿时间 RECEIVED DATE | 2021-07-17
中图分类号 | TU984, X171.4, X52
文献标识码 | C

本期作者以待治理区域的现状问题为导向，通过厘清问题—识别成因—制定策略—提出举措等一系列行动，开展流域生态保护与修复实践探索，并结合河流认知、绘画等人文艺术角度进行了不同维度的解读。袁兴中等人遵循要素—结构—功能—过程的逻辑思路，提出了河/库岸界面生态设计技术的基本框架，并将其应用于重庆市三峡库区澎溪河河/库岸带生态系统修复设计与实践研究中。魏俊等人以茅洲河（宝安片区）水环境综合治理工程为例，从流域水环境治理与水生态修复两个层面，开展了基于源—网—厂—河系统理念的流域生态协同整治，建立了针对水环境综合治理、河流底质栖息环境优化、多目标生态补水及滨水生态修复的全要素治理技术体系。俞孔坚等人以郑州黄河滩地公园为例，探索了黄河滩区生态修复的多目标韧性模式设计，通过科学识别黄河嫩滩、二滩和高滩的特征，落实分区、分类施策的三滩生态修复措施，来突出黄河滩地原真性和自然性特色，完善供给、调节、支持和文化全方位的生态系统服务。杰西卡·M·汉森等人讲述了美国洛杉矶河近百年来由渠化、功能化治理转向自然化、生态化的历程，通过规划重新连接河流与周边人类活动社区，旨在提升生态系统服务功能、形成欣欣向荣的城市居所和相互串联的滨河公园网络。特蕾萨·鲁斯维克等人采用营造河口湿地的措施来处理北美五大湖流域的河口沉积物，为中国开展环保疏浚及生态清淤提供了借鉴方案。劳雷尔·麦克雪莉对比了英国苏格兰的克莱德河和美国特拉华河的相关研究成果，展现了可表达增量变化、叠加及时间推移的横断面模型与相关绘图实践，介绍了以横断面为基础的实践项目对于其他学科领域观察和分析景观现象的实用意义。普拉库·波塔普突破传统认知，将设计场地卢尼河理解为介于云层和含水层之间的“水分关键带”——一处拥有丰富多元文化的开敞空间，并运用绘画、摄影、版画和蒙太奇等方法，构建了两个“乐器”装置，突破了刻板固定、一刀切的场地设计与使用方式。

借由本期从多维视角及差异化策略展开的流域生态保护与修复研究及实践分析，我们尝试从自然、社会、经济、文化等多个视角对水生态保护与修复进行系统认知，并通过差异化策略，探讨在不同区域实现社会经济繁荣、高质量发展及水生态系统健康与可持续等多方面目标的路径，以期在河湖水生态治理中更好地满足新阶段人民日益增长的美好生活需要。推进流域生态治理首先要尊重自然、敬畏自然，识别自然系统的基本规律，并推动水利工程学、生态学、水文学、景观学等多学科交叉，以及科学研究、规划设计、管理实施等多行业协同，立足现实、适度前瞻，共同建设安全、洁净、健康、美丽的河湖水系，有序发挥河湖生态系统服务功能，保障人类社会的可持续发展。**LAF**

Tianmen Mountains are cut through by the Chujiang River,
Where clear water waves roll east then eddy here.
Verdant mountains unfold themselves slowly, at my left and right,
As my solitary sail drifting afar from where the sun rises.

—Li Bai, View of Tianmen Mountains

The poem of “View of Tianmen Mountains” describes a dynamic harmonious picturesque scenery of the boat, river, and human over a thousand years ago, when the Chinese poet Li Bai travelled down the Yangtze River with mountains towering along the rushing river. Similar to the sincere admiration for the beauty of nature expressed in this poem, people nowadays still pursue a healthy water environment that supports a beautiful live.

Ecological processes in river ecosystems can be evaluated by structure, service, landscape heterogeneity, patchiness, vegetation, biomass, etc., which are closely related to hydrological factors

and processes. Meanwhile, the scopes of ecological processes mostly overlap with those of hydrology at a basin scale[1]. As spatial units divided naturally, basins are elementary units of terrestrial water cycle and thus, the optimal units for ecological conservation and management practice[2]. Geography, climate, geology, and land use of basins determine the physical and hydro-chemical features of rivers (e.g., runoff, channel, substrate, water and sediment), which have profound impacts on river basin ecosystems.

However, contemporary river basin development in China is facing challenges due to existing stage of a primary exploration on basin development and management[3]. In response, since 2012, China has launched package plans to build a beautiful China with less air, land, and water pollution. Water governance approaches, such as giving priority to water conservation, balancing space, reinforcing systematic management, and encouraging collaboration between government and marketing, as well as national policies on the Yangtze River and the Yellow River, are proposed to facilitate ecological civilization construction. By now, main tasks of water ecosystem conservation and restoration include clarifying relevant concepts, identifying existing problems, analyzing the causality, proposing general guidelines and key initiatives, and establishing a supporting system[4]. Thus, it is necessary to comprehensively understand water ecosystems from multi-dimensional perspectives—processes of ecosystem services, history, culture, and art—at the basin scale. Moreover, differentiated strategies should be proposed to adjust to varied natural resource endowment, and socio-economic and cultural heritage in different regions.

In this issue on Ecosystem Conservation and Restoration of Regional River Basins, scholars, planners, and designers all over the world are invited to re-conceptualize the relationship between damaged water ecosystems and hydrological processes from multiple perspectives and to contribute to differentiated strategies suitable for regional characteristics of river basins.

Authors interpreted their research and practice on regional river basin ecological conservation and restoration through the process of identifying problems and causes, and proposing initiatives and strategies, together with other perspectives from paradigm shift and cultural concerns. Yuan Xingzhong et al. proposed a technical framework for the ecological design of river/reservoir interface in line with an "element–structure–function–process" workflow, and verified it in the case study of the ecological restoration of the river/reservoir interface in Pengxi River Reach in the Three Gorges Reservoir area in Chongqing. Wei Jun et al. took the Maozhou River (Baoan Section) water environmental remediation in Shenzhen, Guangdong Province as an example to propose an ecological restoration collaborative governance framework based on the "source–network–plant–river" concept, from aspects of river basin environmental management and water ecological restoration. A full-element-treatment technique roadmap was then developed for water environment management, improvement of riverbed habitat, multi-objective eco-water recharge, and waterfront ecological restoration. Yu Kongjian et al. took Zhengzhou Yellow River Floodplain Park as a case study to identify the lower floodplain, intermediate floodplain, and higher floodplain. Site-specific ecological restoration strategies were suggested to celebrate the natural and local characteristics of each floodplain to improve the provisioning, regulating, supporting, and cultural ecosystem services. Jessica M. Henson et al. described the journey of the Los Angeles River in the United States over the past hundreds of years by switching from channelization and functional management to natural and ecological governance processes. A plan was proposed to reconnect the river and urban lives, and enhance ecosystem functions to create a thriving urban habitat and connected network of parks along the river. Theresa Ruswick et al. addressed rivermouth sediments of the North American Great

Lakes by creating wetlands, which can provide reference for environmental and ecological dredging in China. Laurel McSherry's comparative study of River Clyde and Delaware showed that transect modeling and related drawing practice can engage incremental change, accumulation, and time, as well as the interdisciplinary usefulness of transect-based practice for observing and analyzing landscape phenomena. In another case study, instead of seeking to understand Luni-as-a-river differently, Prakul Pottapu pursued a different understanding of *Luni* as a "critical zone of wetness" that extended from clouds to aquifers. As a culturally vibrant open terrain, two instruments were built by techniques of drawing, photography, printmaking, and montage, breaking away from the rigid and separate approaches with landscape designing.

In this issue, through research and practice, *LA Frontiers* attempts to acquire a systematic understanding on regional river basin ecological conservation and restoration. By differentiated strategies, multiple goals of socio-economic prosperity, high-quality development, and healthy and sustainable water ecosystems can be achieved to fulfill people's ever-growing needs for a better life. To propel management of river basin ecosystems, we should first respect the nature, and identify the basic rules of natural systems; then promote the collaboration between Hydraulic Engineering, Ecology, Hydrology, and Landscape, as well as that between scientific research, planning and design, and management and implementation. Only in this way, and with an appropriate and practical prospective, can we realize the vision of safe, clean, healthy, and beautiful rivers and lakes whose ecosystem services can better support sustainable development of humans. **LAF**

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