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Editorial

River Ecological Restoration and Groundwater Artificial Recharge II

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The depletion of rivers and groundwater caused by climate change and human activity is threatening water security and ecosystems. In order to mitigate this trend, some initiatives have been implemented, including the ecological restoration of rivers and the artificial recharge of groundwater [1,2]. For instance, the South-to-North Water Diversion Project [3,4], the ecology water replenishment of the Yongding River in Beijing, and the comprehensive treatment of groundwater overexploitation [5] have been instrumental in alleviating the depletion of water resources in North China. However, these actions can change the natural connections between river water and groundwater, affecting their hydrological characteristics and the exchange of materials between them [2]. Currently, the responses of rivers and groundwater to these behaviors and the mechanisms behind them are not fully understood. As a result, the Special Issue "River Ecological Restoration and Groundwater Artificial Recharge" was created in March 2022 to review and present advanced methodologies, recent progress and challenges, and future opportunities in this field. The first Special Issue comprised 10 papers that discussed the impacts of river ecological replenishment and groundwater recharge on watershed ecology and groundwater quality, as well as the sustainable utilization of water resources at the regional and basin scale. Unfortunately, due to the limited capacity of the publication, many excellent studies could not be included. In response to the requests of the authors and readers, a second Special Issue was created to further enrich our understanding of this issue.

This Special Issue comprises fifteen papers encompassing three interlinked research fields. Three papers focused on revealing the hydrobiogeochemical cycles existing in riverbank filtration. Seven papers focused on the sources, distribution, and transformation of various types of pollutants in river–groundwater systems. Five papers focused on the impacts of climate change and human activities on groundwater dynamics.

Riverbank filtration (RBF) is an important part of the surface water–groundwater cycle, and it intercepts and retains many pollutants present in rivers. Understanding the material cycling process is of paramount importance for the comprehension and implementation of RBF. During groundwater recharge using RBF, pollutants such as ammonium and COD enter the aquifer and change the hydrogeochemical processes and microbial community structure, which in turn causes the release of elements such as Fe, Mn, and As (described in contributions 1–3).

The effects of human activity on the quantity and quality of water in river–groundwater systems can change the migration and transformation behaviors of pollutants in river water and groundwater [6]. Research on the physicochemical behavior of pollutants in river–groundwater systems is crucial for understanding their risks and their subsequent control [7,8]. The behavior of different types of pollutants is determined by different factors such as their sources and properties. The anthropogenic influence on inorganic contamination is mainly seen in the release of poor-quality primary components from aquifers

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(especially in mining areas) caused by changes in hydrodynamic conditions, such as fluorine contamination from red mud pits (contribution 4) and uranium from sandstone-type mines (contribution 5). The behavior of insoluble organic contaminants (e.g., petroleum hydrocarbons) in the zones of groundwater level fluctuation is sensitive to changes in the water level caused by artificial recharge, especially under freezing and thawing cycles (contributions 6–7). In addition, ecological replenishment strongly alters the hydrodynamic conditions and chemical composition of surface water, which in turn causes the secondary release of pollutants, such as heavy metals (contribution 8), pharmaceuticals, and personal care products (PPCPs) (contribution 9), from sediments. With different types of contaminants and distinct aquifer conditions, the choice of water treatment also needs to be assessed comprehensively from a multi-dimensional perspective to prevent potential pollution risks (contribution 10).

Groundwater dynamics, which are under the influence of climate change and human activity, is a coupled natural–human system problem, and numerical simulation is an effective tool for studying it. Authors have combined fuzzy mathematics, random forests, and climate models with groundwater models to study groundwater dynamics under different scenarios, such as ecological recharge (contribution 11), riverbank filtration (contribution 12), and artificial recharge (contribution 13). The impact of climate change on the sustainable utilization of water resources is also discussed and studied in detail (contributions 14–15).

These published papers provide useful scientific evidence that could lead to a better understanding of the relationship between river water and groundwater impacted by human activity and climate change. We believe that these high-quality papers have important value as references for the sustainable management of water resources and the protection of water ecological security.

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List of Contributions:

1. Xia, X.; Teng, Y.; Zhai, Y. Effects of Ammonium and COD on Fe and Mn Release from RBF Sediment Based on Column Experiment. *Water* **2023**, *15*, 120. https://doi.org/10.3390/w15010120
2. Lu, S.; Yang, Y.; Yin, H.; Su, X.; Yu, K.; Sun, C. Microbial Community Structure of Arsenic-Bearing Groundwater Environment in the Riverbank Filtration Zone. *Water* **2022**, *14*, 1548. https://doi.org/10.3390/w14101548
3. Zhang, B.; Chen, L.; Li, Y.; Liu, Y.; Li, C.; Kong, X.; Zhang, Y. Impacts of River Bank Filtration on Groundwater Hydrogeochemistry in the Upper of Hutuo River Alluvial Plain, North China. *Water* **2023**, *15*, 1343. https://doi.org/10.3390/w15071343
4. Qi, Y.; Zhou, P.; Wang, J.; Ma, Y.; Wu, J.; Su, C. Groundwater Pollution Model and Diffusion Law in Ordovician Limestone Aquifer Owe to Abandoned Red Mud Tailing Pit. *Water* **2022**, *14*, 1472. https://doi.org/10.3390/w14091472
5. Zheng, F.; Teng, Y.; Zhai, Y.; Hu, J.; Dou, J.; Zuo, R. Geo-Environmental Models of In-Situ Leaching Sandstone-Type Uranium Deposits in North China: A Review and Perspective. *Water* **2023**, *15*, 1244. https://doi.org/10.3390/w15061244
6. Huang, J.; Zhong, R.; Lyu, H. Investigating the Change Pattern in Adsorption Properties of Soil Media for Non-Polar Organic Contaminants under the Impact of Freezing and Thawing. *Water* **2023**, *15*, 2515. https://doi.org/10.3390/w15142515

7. Zhou, J.; Pan, M.; Chang, C.; Wang, A.; Wang, Y.; Lyu, H. Migration Law of LNAPLs in the Groundwater Level Fluctuation Zone Affected by Freezing and Thawing. *Water* **2022**, *14*, 1289. https://doi.org/10.3390/w14081289
8. Liu, T.; Zhang, D.; Yue, W.; Wang, B.; Huo, L.; Liu, K.; Zhang, B.-T. Heavy Metals in Sediments of Hulun Lake in Inner Mongolia: Spatial-Temporal Distributions, Contamination Assessment and Source Apportionment. *Water* **2023**, *15*, 1329. https://doi.org/10.3390/w15071329
9. Pei, S.; Li, B.; Wang, B.; Liu, J.; Song, X. Distribution and Ecological Risk Assessment of Pharmaceuticals and Personal Care Products in Sediments of North Canal, China. *Water* **2022**, *14*, 1999. https://doi.org/10.3390/w14131999
10. Li, J.; Wen, Y.; Jiang, J.; Tan, W.; Zhang, T. A Multi-Dimensional Comprehensive Assessment (MDCA) Method for the Prioritization of Water Pollution Treatment Technologies in China. *Water* **2023**, *15*, 751. https://doi.org/10.3390/w15040751
11. Nan, T.; Cao, W. Effect of Ecological Water Supplement on Groundwater Restoration in the Yongding River Based on Multi-Model Linkage. *Water* **2023**, *15*, 374. https://doi.org/10.3390/w15020374
12. He, Z.; Kang, B.; Tao, Y.; Qin, L. Mining Scheme for Small Rivers near Water Sources—A Case Study of Liuan River in Linquan County, China. *Water* **2022**, *14*, 1921. https://doi.org/10.3390/w14121921
13. Asmael, N.; Dupuy, A.; McLachlan, P.; Franceschi, M. Hydro-Geochemical Characteristics of the Shallow Alluvial Aquifer and Its Potential Artificial Recharge to Sustain the Low Flow of the Garonne River. *Water* **2023**, *15*, 2972. https://doi.org/10.3390/w15162972
14. Qi, X.; Li, W.; Zheng, Y.; Cui, H.; Kang, W.; Liu, Z.; Shao, X. Coupling Simulation and Prediction of Sustainable Utilization of Water Resources in an Arid Inland River Basin under Climate Change. *Water* **2023**, *15*, 3232. https://doi.org/10.3390/w15183232
15. Hou, X.; Yang, H.; Cao, J.; Feng, W.; Zhang, Y. A Review of Advances in Groundwater Evapotranspiration Research. *Water* **2023**, *15*, 969. https://doi.org/10.3390/w15050969

References

1. Wohl, E.; Lane, S.N.; Wilcox, A.C. The science and practice of river restoration. *Water Resour. Res.* **2015**, *51*, 5974–5997. [CrossRef]
2. Dillon, P.; Stuyfzand, P.; Grischek, T.; Lluria, M.; Pyne, R.D.G.; Jain, R.C.; Bear, J.; Schwarz, J.; Wang, W.; Fernandez, E.; et al. Sixty years of global progress in managed aquifer recharge. *Hydrogeol. J.* **2019**, *27*, 1–30. [CrossRef]
3. Nong, X.; Shao, D.; Zhong, H.; Liang, J. Evaluation of water quality in the South-to-North Water Diversion Project of China using the water quality index (WQI) method. *Water Res.* **2020**, *178*, 115781. [CrossRef] [PubMed]
4. Long, D.; Yang, W.; Scanlon, B.R.; Zhao, J.; Liu, D.; Burek, P.; Pan, Y.; You, L.; Wada, Y. South-to-North Water Diversion stabilizing Beijing's groundwater levels. *Nat. Commun.* **2020**, *11*, 3665. [CrossRef] [PubMed]
5. Yang, H.; Cao, W.; Zhi, C.; Li, Z.; Bao, X.; Ren, Y.; Liu, F.; Fan, C.; Wang, S.; Wang, Y. Evolution of groundwater level in the North China Plain in the past 40 years and suggestions on its overexploitation treatment. *Geol. China* **2021**, *48*, 1142–1155. [CrossRef]
6. Wei, Y.; Chen, Y.; Cao, X.; Xiang, M.; Huang, Y.; Li, H. A Critical Review of Groundwater Table Fluctuation: Formation, Effects on Multifields, and Contaminant Behaviors in a Soil and Aquifer System. *Environ. Sci. Technol.* **2024**, *58*, 2185–2203. [CrossRef] [PubMed]
7. Min, L.; Liu, M.; Wu, L.; Shen, Y. Groundwater Storage Recovery Raises the Risk of Nitrate Pollution. *Environ. Sci. Technol.* **2022**, *56*, 8–9. [CrossRef] [PubMed]
8. Zang, Y.; Hou, X.; Li, Z.; Li, P.; Sun, Y.; Yu, B.; Li, M. Quantify the effects of groundwater level recovery on groundwater nitrate dynamics through a quasi-3D integrated model for the vadose zone-groundwater coupled system. *Water Res.* **2022**, *226*, 119213. [CrossRef] [PubMed]