Response to reviewers' comments on "Evaluating Long-Term Effectiveness of Managed Aquifer Recharge for Groundwater Recovery and Nitrate Mitigation in an Overexploited Aquifer System" by Y. Zhu, Z. Guo, S. Wan, K. Chen, Y. Wang, Z. Zeng, H. Shen, J. Ye, and C. Zheng

Reviewer's comments in black; Response to reviewer' s comments in blue; Revisions in the revised manuscript in red.

We would like to thank the editor and the reviewer for their constructive comments, which have helped us improve the presentation of this work. We have revised our manuscript according to the reviewer's comments and have provided below a point-by-point response to the reviewer's comments.

Reviewer #1

The authors addressed my comments satisfactorily. They provide a detailed response to my first question in review, but they did not include their detailed response in the revised text. Instead, they presented a shorter version there.I will suggest they include a detailed explanation in the revised text, rather than the shorter version, as this is an important issue. A minor revision is required.

Response:

Thank you for the suggestion. We have incorporated the detailed explanation from our previous response into the revised manuscript as requested.

Revisions have been made in lines l21-134:

"Although denitrification inherently involves complex enzymatic pathways and intermediate products, a simplified two-step reduction scheme was adopted in this study based on the specific hydrogeological context of the Xiong'an New Area. First, the shallow aquifer system is characterized by predominantly oxidizing conditions, as evidenced by high dissolved oxygen concentrations and a scarcity of organic electron donors (Li et al., 2023). Under such biogeochemical constraints, the overall reaction rate is governed primarily by the availability of electron donors and the inhibition threshold of dissolved oxygen, rather than by the transformation kinetics of intermediate species. Reflecting this, the kinetic formulation in Equation (5) incorporates dual-Monod terms to explicitly represent donor limitation and oxygen inhibition, effectively capturing the rate-limiting steps. Second, the regional-scale and long-term nature of the simulation (536 km^2) necessitates a balance between mechanistic detail and computational feasibility. The two-step reduction scheme ensures the conservation of nitrogen mass balance while maintaining numerical efficiency, avoiding the excessive parameter uncertainty associated with complex multi-step reaction networks. This approach aligns with established practices in regional reactive transport modeling (Guo et al., 2023; Karlović et al., 2022; Jin et al., 2024)."

Revisions have been made in lines 331-333:

"This outcome validates the suitability of the adopted two-step reduction scheme (Equation 5), which effectively captures the suppression of denitrification rates under such donor-poor and oxidizing conditions."

Revisions have been made in lines 416-418:

"These field observations justify the exclusion of complex multi-step reaction networks in our model, as the scarcity of primary electron donors constitutes the rate-limiting step rather than intermediate transformation pathways."

References

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Karlović, I., Posavec, K., Larva, O., and Marković, T.: Numerical groundwater flow and nitrate transport assessment in alluvial aquifer of Varaždin region, NW Croatia, Journal of Hydrology: Regional Studies, 41, 101084, https://doi.org/10.1016/j.ejrh.2022.101084, 2022.

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Reviewer #2

My previous concerns have been well addressed but some minor language errors have been noticed which can be handled in publication procedure. Overall, I recommend acceptance for publication and suggest careful language check.

Response:

Thank you for your positive feedback and the recommendation for acceptance. We have carefully proofread the manuscript again to correct potential language errors as suggested.