Dear Reviewer#2,

We sincerely appreciate your careful review and insightful suggestions. We also thank you for your patience in identifying these issues and helping us improve the manuscript. The author team has discussed your comments in detail and will address them thoroughly in the revised manuscript to improve the clarity of the text and the presentation of the figures. Below, we provide detailed point-by-point responses to all comments. Your comments are presented in **bold**, and our responses are given in regular text.

Sincerely,

Zhuoxin Chen (on behalf of all authors)

General comments

This is my first review of the manuscript "Regulatory role of permanent gully in runoff dissolved nitrogen and phosphorus transport across rainfall types" by Chen et al.

This paper investigated the influence of gullies on runoff and nutrient transport (nitrogen and phosphorous) in two small catchments in Northeast China, and how this influence changed under three different rainfall types. The authors found that gullies contributed to total runoff mostly during frequent, low-depth, low erosivity rainfall events, and they diluted dissolved NH4+, NO3-, and P concentrations. Loss of dissolved N and P were mainly caused by long duration, high erosivity rainfall events.

The topic of this manuscript is relevant and important, it is of interest for the community. A few major comments, as well as minor technical corrections are listed below.

Response: We feel truly honored to have the opportunity to receive your guidance and sincerely appreciate your positive evaluation of our manuscript. Although the research topic addressed in our study has received relatively limited attention worldwide, your insightful comments have helped us recognize several shortcomings in our writing and presentation. In particular, certain textual expressions and figure presentations can be further refined and clarified. We will carefully consider each of your suggestions and revise the manuscript accordingly to improve its overall quality and rigor. Thank you again for your constructive and thoughtful comments. We will do our utmost to revise the manuscript into a version that meets your expectations.

Specific comments

1. The study presents two gullies close to each other in Northeast China. Please provide information on the generalizability of the findings.

Response: Thank you very much for your valuable suggestion. In Northeast China, approximately 667,000 gullies have been identified, of which more than 85% remain active and over 70% are developed in cropland. Prior to conducting this study, we carried out a comprehensive gully inventory survey in the study area (Lines 95–100). The selected gullies are representative of the average characteristics of active gullies in this region. Therefore, we conservatively state that our findings are at least representative for this region. It should also be noted that our previous study published in the *Journal of Hydrology* in 2025 demonstrated the significant sediment-enhancing effect of these gullies,

which is generally consistent with observations reported worldwide. However, few studies to date have specifically examined how gullies regulate dissolved nitrogen and phosphorus losses under different rainfall types. Based on your suggestion, we will further clarify the broader significance and general applicability of this study in both the Abstract and Discussion sections to better highlight its wider relevance.

2. The authors should identify clear research gaps in literature in the Introduction section. After listing several references and literature on gullies, the sentence in the Introduction saying "Nevertheless, the role of gullies in modulating dissolved nutrient losses under varying rainfall conditions remains insufficiently investigated." does not seem to be justified.

Response: Thank you very much for pointing out this weakness in the Introduction. After carefully revisiting this section, we agree that the discussion of the research gaps was not sufficiently in-depth. In the revised manuscript, we will refine this part accordingly. Specifically, we will expand the review of previous studies worldwide that have examined the effects of gullies on dissolved nutrient transport. In fact, we have already begun to incorporate and synthesize these relevant studies. In addition, we will reorganize the logical structure of the Introduction to address several weaknesses in the flow of argumentation and to ensure a clearer progression from background to research gap and objectives. The literature review will also be strengthened to better position our study within the broader international context. We believe that these revisions will make the Introduction more rigorous, coherent, and persuasive.

3. The results should be reproducible. The methodological description is not complete, often it is

hard to understand how the results were obtained (e.g., events selection, calculation of volumes and masses, statistical analyses, etc.). The methods section should be extended.

Response: Thank you very much for your valuable comments on the Methods. We fully agree that several aspects of the methods section were not described with sufficient clarity, particularly regarding the calculation of certain indices. With respect to rainfall event selection, we monitored all rainfall events during the two rainy seasons that generated observable surface runoff. However, our description was not sufficiently precise, especially in the use of terms such as "erosive rainfall." In the revised manuscript, we will refine and clearly define these terms to avoid ambiguity and improve readability. Regarding hydrological monitoring and calculations, we will provide a more detailed description of the monitoring procedures and include the relevant calculation formulas to enhance transparency and reproducibility. In addition, we will further elaborate on the statistical analyses applied in this study, including correlation analysis and other relevant methods, to ensure that the analytical framework is clearly presented and scientifically rigorous.

4. The Discussion section should be strengthened by more data-based process understanding and interpretation of the results and referring to more and relevant studies in literature.

Response: We fully agree with this comment. In the revised manuscript, we will enhance the data-driven interpretation of the observed patterns and further discuss the hydrological and biogeochemical processes underlying nutrient transport. We will also incorporate additional relevant studies to strengthen the scientific context of our findings.

5. Readers should be able to understand each figure without reading the entire methods and

results section, figures with their captions should be interpretable alone, without the entire manuscript. Please extend the figure captions by explaining each subfigure (a, b, c, etc.), and add legends where they are missing.

Response: Thank you very much for pointing out these issues. We fully agree that it is inappropriate to expect readers to search through the entire manuscript to understand the information presented in the figures. We have recognized this shortcoming. In the revised manuscript, we will provide more detailed and self-explanatory figure captions and supplement any missing legends, ensuring that each figure can be clearly understood on its own without requiring cross-reference to the main text.

6. Can the findings (e.g., dilution effect of the gully, etc.) be attributed really to the influence of the gully or dilution could be caused by e.g., subsurface contributions? On a similar note, were the catchment characteristics (land use, subsurface, etc.) the same/similar between the upstream catchment area (until the inlet of the gully) and the rest of the catchment?

Response: Thank you very much for your constructive suggestion. We will provide a more detailed description of subsurface runoff and land use conditions in the Materials and Methods section. In this study, no subsurface runoff was observed during dry periods. Even during rainfall events, runoff generation and recession occurred rapidly, indicating that subsurface flow contributed negligibly to the overall hydrological response. Therefore, its influence on runoff and associated sediment and nutrient losses can be considered minimal. Regarding land use, the catchments are predominantly cultivated farmland. Field observations showed that limited woodland areas are distributed along both sides of the gullies. However, during rainfall events, runoff from these woodland patches rarely entered the gully system, and surface runoff generation within these areas was minimal. As a result, their

contribution to total runoff was very small, and we consider their impact on the overall results to be negligible. Based on your valuable comment, we will add a subsection in the third part of the Discussion to explicitly address the limitations of this study. We sincerely appreciate your thoughtful feedback, which has helped us improve the clarity and rigor of the manuscript.

7. In certain parts of the Results section, the text does not seem to be justified by the figures (please see details in technical corrections later).

Response: Thank you very much for your careful and detailed comment. We will thoroughly re-examine the correspondence between the figures and the text throughout the manuscript and ensure that all relevant figure citations are clearly indicated. This revision will improve the traceability of the results and make the sources of the presented findings more explicit and transparent.

8. It is good that the Results section is compact, but using one single sentence to describe a complex plot seems to be not enough. If a figure contains the same message as another figure and not much text can be added, then such a figure should be removed or added to the Appendix.

Response: We fully agree with your suggestion. Based on your comment, we plan to move Figures 8 and 9 to the Supplementary Materials so that the main results can be presented in a more concise and focused manner. The revised manuscript will provide clearer presentation and more streamlined descriptions of the key findings.

9. The authors refer to the area of the gullies (i.e., 12.4% of the catchment area; still, they contribute so much runoff to the total runoff, "36.1% of total runoff")? Would it not be more

meaningful to refer to the drainage area of the gullies in this context, i.e., the catchment area where they collect the water from? Did I understand correctly that at the "outlet" (red points in Figure 1) the catchment area contributing to runoff is the entire catchment area, i.e., 100% of the catchment? Then what do the two percentages 12.4% and 36.1% refer to? But more generally: the authors should better explain in the study area or methods section: what do "UDGH", "Gully" and "Outlet" refer to, when (permanent/ephemeral?) and where (drainage areas?) does the water flow? On a similar note, some photos (of the gauges, gullies, etc.) might help the readers to imagine the study area and instrumentations.

Response: Thank you very much for pointing out these potentially confusing issues. In the revised manuscript, we will provide clearer definitions of UDGH and Outlet in the Materials and Methods section. In this study, the 12.4% refers to the proportion of the gully area relative to the total catchment area defined at the outlet. The 36.1% represents the runoff generated within the gully itself, calculated as the total runoff at the outlet minus the runoff produced from the upslope drainage area above the gully head. We acknowledge that this proportion may be slightly overestimated because a small fraction of runoff from the gully banks could not be directly monitored. However, according to our field observations, runoff from the gully banks rarely enters the gully due to the presence of wheel tracks and vegetated buffer strips (Lines 107–110), and the volume of such runoff is minimal. Therefore, its influence on the overall results is likely negligible. We will explicitly discuss this issue in the limitations section of the revised manuscript. In addition, as noted earlier, the gullies developed on hillslopes in this region receive no groundwater contribution during dry periods, and groundwater effects can also be disregarded during rainfall events. To improve clarity and transparency, we will also add photographs of the monitoring equipment and representative images of gully development to

help readers better understand the study setting and methodology.

10. The manuscript would greatly benefit from thorough English language editing, please find below some technical corrections, but the list is not complete.

Response: We sincerely appreciate your detailed and highly professional comments. It is a great honor for us to receive guidance from such a respected reviewer. In response to your suggestions, we will carefully discuss the manuscript with several senior members of our research team and conduct a thorough re-examination of the entire paper. We will revise sections where the expression is unclear, the logic is not sufficiently coherent, or the figures and tables lack clarity. Particular attention will be given to improving the overall structure, precision of language, and the presentation of results. We look forward to submitting a substantially improved version of the manuscript. With your comprehensive and constructive feedback, we are confident that we can significantly enhance the quality and rigor of this work.

As the remaining comments mainly involve specific technical corrections, we have organized our responses in a tabular format to facilitate a clearer and more direct comparison between each comment and our corresponding response. The left column presents your comments, and the right column provides our replies.

Technical corrections	Response
title, line 14, etc.: "runoff-"dissolved nitrogen? Is this term correct/does this term exist? Or	Thank you for your suggestion. We will correct it throughout the entire text to "dissolved

dissolved nitrogen in runoff?	nitrogen / phosphorus in runoff".
Line 16: permanent gully in a catchment	We will carefully revise and correct these details in the revised manuscript.
Line 16: losses or dynamics?	
Line 17: please define NH4+, etc. before using the term	
Abstract: please also describe in 23 sentences which methods were used.	
Line 27: by the gullies?	
Line 28: improving how? Please be specific	We will further refine and elaborate on the research implications based on the discussion presented in Section 3.
Lines 42-43: repetition of lines 3738	We will rewrite this section to improve its clarity and coherence.
Line 49: riparian buffers? Do you mean riparian zone?	Thank you for this important clarification. The area referred to here is not a typical riparian buffer or riparian zone. Instead, it is a vegetated gully bank adjacent to cropland. In this region, the gully bank serves as a tractor-turning area, where wheel tracks frequently develop. During rainfall events, these surface irregularities, together with relatively dense grass cover, can partially impede direct runoff entering the gully. To avoid conceptual confusion, we will replace "riparian buffer" with "vegetated gully bank"

	and clarify its functional role in the revised manuscript.
Line 58: high frequency? Do you mean more common/events that occur more often? Please try to rephrase	Thank you for this clarification. We acknowledge that the previous wording was not sufficiently precise. We will revise the expression to ensure more accurate and unambiguous communication in the revised manuscript.
Line 59: efficiencies? In what?	We will remove this ambiguous word.
Line 63: concentration gradients? Please explain	
Lines 42-67: research gaps should be identified, what is missing in literature? This should be justified.	Please refer to the answer to Question 2.
Lines 68-78: how is this paragraph logically linked to the previous? Please keep a logical flow of thoughts/sentences/paragraphs – these need to be logically linked	
Line 79: please first define terms NH4+, etc	We will correct it throughout the entire text.
Line 82: gullies?	
Introduction last sentence should be more specific	We will further refine and clarify our research methods and study scope in the final paragraph.
Line 87: (1), later (2) etc. – are these numbers necessary? Why were they added?	Yes, we don't really need them. We'll remove these serial numbers.
Fig 1: please add some photos of the gullies	We will add a land-use distribution map and

Line 102: land use proportions? Please explain here term	include UAV photographs in the revised manuscript to better illustrate the spatial context and further clarify the activity status of the gullies.
Line 104: please remove "within catchment"	We will delete it.
Line 105: "F1 measured" please rephrase, F1 is a catchment?	Yes, F1 is a catchment area. What we mean by this is the total area of the catchment area.
Please extend all figure captions Line 114: rainfall data (please remove capture)	We will correct it throughout the entire text.
Line 115: resolution of 0.2 mm? please explain which type of gauge was used	We used a tipping-bucket rain gauge in this study. In the revised manuscript, we will include a photograph of the instrument in Fig. 1 and provide a corresponding description to improve clarity.
Line 116: there was one gauge within one catchment – spatially heterogenous rainfall could not be recorded in one catchment – differences between the catchments could be recorded	Yes, we will rewrite this section and reframe it to focus on rainfall variability.
section 2.2: please explain how exactly events were selected, which thresholds were used, how was the beginning and end of a rainfall event defined? And how was the beginning and end of the corresponding runoff event defined? Line 118: what is significant? And how was soil	Thank you for this important comment. We would like to clarify that no rainfall events were selectively chosen. During the two-year monitoring period, all rainfall events that generated clearly observable runoff in the catchments were included in the dataset. The

erosion measured?	previous wording referring to "erosive rainfall" may have caused misunderstanding, and we will revise this section to describe the event selection criteria more clearly. Regarding the definition of runoff initiation and termination, the monitored catchments are hillslope systems without baseflow under dry conditions. Runoff occurred only during rainfall events and ceased shortly after rainfall stopped. Therefore, the onset and end of runoff were clearly identifiable during the monitoring period. We will clarify this methodological detail in the revised manuscript.
Line 120: usually rainfall erosivity is EI30 in literature	We thank you for this professional and insightful comment. We acknowledge that EI_{30} is commonly used to characterize rainfall erosivity in many studies. In our study, however, we used I_{30} to represent rainfall intensity characteristics and calculated event kinetic energy (E_r) separately to describe rainfall energy. This approach allowed us to examine the individual contributions of rainfall intensity and kinetic energy to runoff and nutrient transport. To avoid confusion, we will further clarify the rationale for using I_{30} and E_r in the revised manuscript.

Line 125: in which equation?	We will correct it.
is the dimension of rainfall kinetic energy correct? It is usually MJ/ha	We agree with your comment. Although MJ ha^{-1} and MJ hm^{-2} are equivalent, MJ ha^{-1} is more commonly used. We will therefore adopt MJ ha^{-1} consistently throughout the manuscript.
Line 126: what is a subevent? Please explain	We will further refine the methodology by providing more detailed descriptions of the monitoring approach and sampling design.
Line 127: what does it mean "based on rainfall intensity", how exactly?	
Line 129: Sample collection? Sampling strategy?	
Line 134: "post runoff stages"? please explain or rephrase	
Line 136: what is sufficient? How many exactly? Please provide some statistics and numbers of the samples	
Line 145: please explain the methods from Chen et al briefly here	
2.4: please extend	We will further refine and clarify the entire analytical framework, including the procedures for difference testing, correlation analysis, and redundancy analysis (RDA), to improve methodological transparency.
Line 156: were these the same events? Why different number of events?	Although the two catchments are located relatively close to each other, convective summer rainfall events can exhibit substantial spatial

	heterogeneity. In fact, during one storm event, significant runoff was generated in the F1 catchment, whereas no measurable runoff occurred in F2. Such spatial variability in storm intensity is common for localized summer rainfall and can lead to differences in hydrological response between nearby catchments.
Please extend table captions	We will provide a more detailed explanation of this aspect in the revised manuscript.
Table 1: D might be more meaningful in hours	
Line 169: which figure shows this? Please provide references, not just at the end of the section	We will ensure that all figures are correctly cited and referenced at the appropriate locations in the revised manuscript.
Line 174: these percentages should be better explained, to what exactly they refer to?	We will further clarify and elaborate on this aspect in the revised manuscript.
Figure 2: how were the volumes defined? Please add to methods	
3.3 title is unclear, effect on what? Please rephrase, also the English	We will revise the section title to: Gully-mediated transport of dissolved NH_4^+, NO_3^-, and P
Line 186: belongs to methods. Why downstream divided by upstream?	We fully agree with your suggestion and will clarify this point in the Materials and Methods section.
Lines 193-195: Fig 4 does not entirely show this	We will remove the inaccurate statement in the

– because the two catchments differ	revised manuscript.
Line 202: transport fluxes: how were they estimated? Please explain in methods	We thank you for this helpful suggestion. We will provide a more detailed description in the Materials and Methods section in the revised manuscript.
Line 205: please add reference to figure	
Line 206: "similarly dominated" please rephrase	
Line 208-209: which figure shows this? Where do these values stem from?	
Figure 5: what does "gully" refer to? To the outlet? What do "sites" refer to in the caption? What is 100%?	
Figure 6: methods should explain how cumulative transport fluxes were obtained?	
Figure 7: methods should explain the scales (event scale? etc)	
3.4.1: correlation analysis should be explained in methods	
Figure 8: legend is missing	We will add a legend explaining the symbol sizes in the revised figure.
Lines 235-236: meaning not clear, please explain or rephrase	We thank you for pointing this out. We agree that the meaning of this sentence is not sufficiently clear. We will rephrase and clarify this part in the revised manuscript to improve readability.
Fig 9: should be explained in methods	We will further clarify the purpose and interpretation of applying RDA in Section 2.4.

Lines 242-245: belongs to methods	We will move this part to the Materials and Methods section in the revised manuscript.
Fig 11: to how many points were these lines fitted? C: line would be flat without that one outlying point – why is that event so different than the others? Were the measurements correct?	Response: We thank you for this careful observation. In this study, Type C rainfall corresponds to high-erosivity events. During the two-year monitoring period, one relatively extreme rainfall event (100–200 mm) was recorded, which appears as the high-value point in Fig. 11. Based on long-term local rainfall characteristics, such events occur roughly once every three years. Therefore, rather than representing a spurious outlier, this data point reflects a naturally occurring high-magnitude rainfall event and enhances the representativeness of our dataset by capturing both regular (Type A and B) and relatively extreme (Type C) conditions. In Fig. 11, the regression patterns differ substantially among rainfall types. As commonly observed, the relationship between nutrient flux and rainfall amount follows linear or power-law forms. The notably steeper slope under Type C rainfall indicates a disproportionately stronger response of nutrient loss to incremental rainfall,

	highlighting its enhanced erosive and transport capacity compared to the more frequent rainfall types.
Line 270: mobilized?	The typical Mollisols in this region are slightly alkaline, under which NH_4^+ is more likely to be retained through cation exchange and adsorption onto negatively charged soil colloids.
Line 272: gullies?	We will thoroughly review the manuscript to ensure grammatical accuracy and improve language clarity where necessary.
Line 279: interception effects of gullies?	We will rewrite this sentence to make the statement more specific and support it with additional relevant literature to better substantiate the role of gullies.
Line 292: the methods do not mention information on land management practise? Was the timing of fertilizer application managed?	We thank you for this helpful reminder. In the revised manuscript, we will describe fertilizer application practices in this region in Section 2.1. Based on our findings and existing literature, we will also discuss potential implications for agricultural management.
Line 295: gullies	We will correct it throughout the entire text.
Line 304: gullies in agricultural catchments play a dual role	