<u>Overall Response to Reviewer Comments</u>

We thank the reviewers for their careful and constructive evaluation of the manuscript. Their comments have helped us identify areas where the presentation and broader framing of the study can be clarified and strengthened. In response, we will incorporate additional text in the revised manuscript to more explicitly highlight the global implications of the results for wetland–climate interactions, flood propagation in wetland-dominated basins, and hydrological modelling of connected lake–river–wetland systems. We will also include a sensitivity analysis of the event-matching parameters and add a schematic graphical workflow to clarify the methodological framework. These additions aim to strengthen the clarity, robustness, and broader process relevance of the study while preserving the core analysis and conclusions. We have uploaded point-by-point responses to the reviewers separately, which include summary results from the sensitivity study and excerpts of the proposed additional text.

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<u>## Reviewer comments are in blue and bold font and author responses are provided below each comment ##</u>

<u>Reviewer 1 comments - author response :</u>

We sincerely thank the reviewer for their careful and constructive evaluation of the manuscript and for recognising its scientific and operational relevance. We are especially encouraged by the reviewer's acknowledgement of the transparent methodology, system-scale framing, and the importance of the transit-time findings for flood forecasting and anticipatory action across the White Nile system. We will address each comment below and revise the manuscript where appropriate to improve clarity, strengthen presentation, and further reinforce confidence in the robustness and applicability of the findings.

1.1 Given the length of the paper, the authors may want to state central claim of the paper which is "the 16.84 months system transit time" which is mentioned in the abstract and only appears again in section 3.3. The authors may want to explicitly contrast it with the commonly held believe that the system transit time is about 5 months to sharpen novelty. This may appear at the end of the introduction.

We will revise the introduction to explicitly highlight the system-scale transit time of ~17 months as a central finding of the study. We will also explicitly contrast this empirically derived value with the commonly cited assumption of approximately 5 months, which largely reflects rainfall-to-river propagation times rather than storage-influenced lake–wetland system dynamics. This should sharpen the positioning of the manuscript and ensure that readers clearly understand the novelty and implications of the findings from the outset.

1.2 There is inconsistency in paragraphs lengths especially in the introduction section of the manuscript. For example, compare L35–50, L51–62, L104–108, L110–126 etc. If possible, the authors should aim to harmonize paragraph lengths to improve readability, unless there is a clear rationale for maintaining the current structure.

We appreciate the reviewer's observation. We will revise the Introduction to improve paragraph balance and readability while preserving the logical structure and scientific core.

1.3 For sensitivity of event matching parameter, whilst the prominence threshold (δ), smoothing window (±15 days), and the 335-day search horizon are defensible, the paper would benefit from a short supplementary sensitivity analysis. For example, show how Victoria-Kyoga-Albert-Sudd lag changes under (i) 7 days smoothing window, and (ii) ±2 months search horizon. This will strengthen confidence that the 16–17-month figure is not the result of the authors subjective decisions.

We thank the reviewer for this suggestion and have now carried out a sensitivity analysis to evaluate the robustness of inferred Lake Victoria to Sudd floodwave transit times to key event-matching parameters. A grid-based one-at-a-time (OAT) sensitivity analysis was conducted in which the smoothing window was varied from 1 to 90 days and the downstream segment search horizon from 20 days to approximately 3 years, encompassing and extending beyond the reviewer's suggested parameter ranges, while the prominence threshold was held fixed at the optimised baseline value.

The results as shown in the contour plot show that inferred transit times are largely insensitive to the smoothing window across the tested range, while the search horizon exerts the dominant control on the resultant lag estimates. For search horizons up to 1.25 years, the tested parameter combinations consistently produce system transit times clustered around ~15–17 months, supporting the mean system transit time reported in this paper. Longer horizons allow matching with Sudd wetland seasonal expansions from later years that are not causally linked to the originating Lake Victoria floodwave, which leads to artificially longer lag estimates. The violin plots, grouped by search-horizon range, illustrate the multimodal distribution of these longer lag solutions when no horizon restriction is applied. Therefore, the analysis confirms that the reported mean system transit time of ~17 months (16.84 ± 1.95 months) represents a robust hydrological signal rather than an artefact of parameter selection.

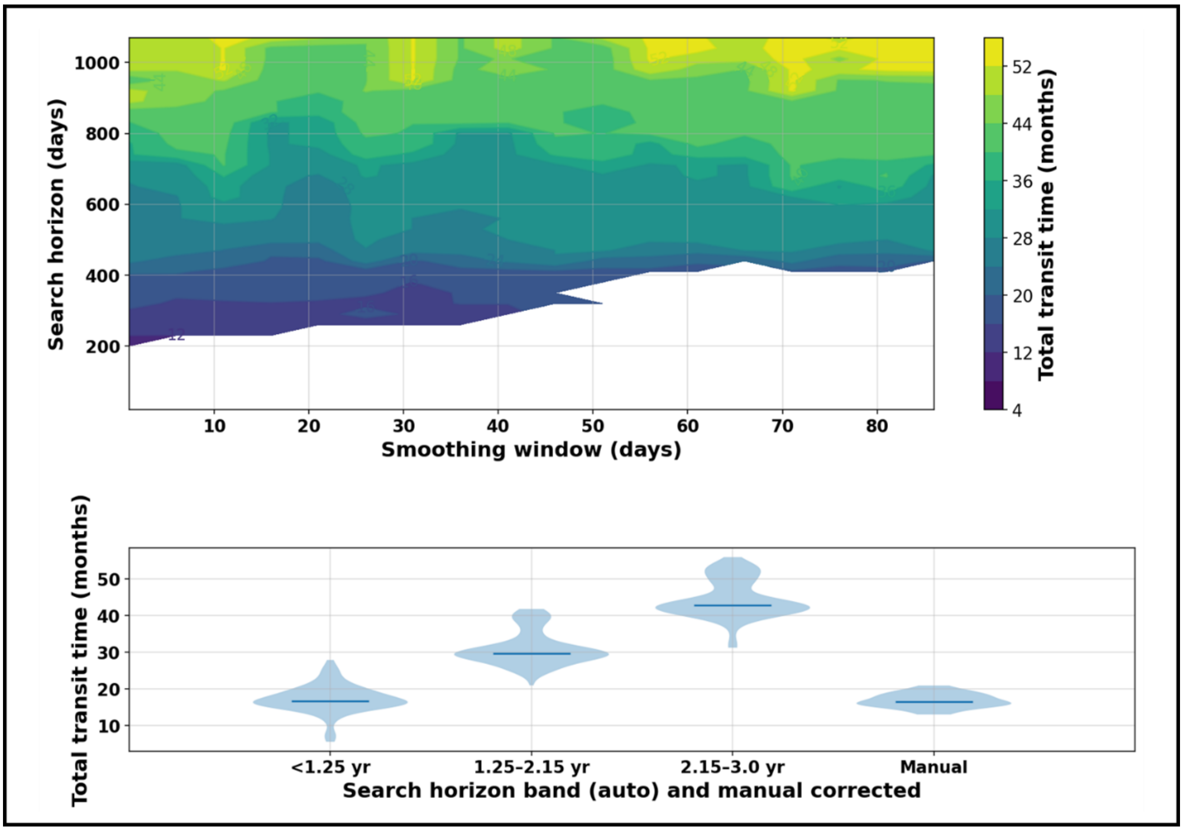

Figure R1:Sensitivity analysis of inferred Lake Victoria–Sudd system transit times to key event-matching parameters. The upper panel shows the contour response of total transit time to variations in smoothing window and downstream search horizon. The lower panel shows violin distributions of inferred transit times grouped by search-horizon range.

1.4 The authors highlighted the absence of publicly available Lake Victoria outflow records; please could the authors add one paragraph in Methods or Discussion section to clarify how this limitation could (or could not) bias the transit-time inference, given that the method uses observed peak lake levels and downstream signals rather than release series.

We will add a paragraph to the Methods section to clarify this limitation and discuss the potential implications of the absence of publicly available Lake Victoria outflow records. While the lack of a continuous release series represents a limitation for analyses that rely directly on discharge records, the present approach infers system transit times by tracking the timing of observed lake level peaks in Lake Victoria and their downstream responses in Lake Kyoga, Lake Albert, and the Sudd wetland system. Because Lake Victoria stores and releases water over long periods, peak lake levels provide a reliable indicator of system-scale hydrological forcing. The downstream timing and extent signals reflect how this stored water propagates through the connected lake and wetland system. While regulated outflows may affect short-term discharge variations, they do not prevent the identification of the broader, storage-driven transit times that this study aims to quantify.

1.5 Could the authors add a link to the MODIS-based inundation masks produced and post-processed by the World Food Programme (WFP) as many readers may not be aware that this dataset exits.

The MODIS-based inundation dataset used in this study is a proprietary product developed and maintained by the World Food Programme (WFP) and is not publicly hosted. Access to the dataset is available from WFP upon request. This will be clarified in Section 2.1.3 of the revised manuscript.

1.6 Consistency in "physical" vs "statistical" timing across figures. Section 3.3 shows physical transits (splines linking matched peaks), and section 3.4 shows r^2-vs-lag curves, consider providing a statement to clarify "what the line connects" vs "what the correlation peak means".

We will add a short clarifying statement in Sections 3.3 and 3.4 to distinguish the physical event tracking from the statistical lag analysis. Specifically, in Section 3.3, the spline-linked peaks represent the sequential tracking of physically matched flood-wave events as they propagate through the Victoria–Kyoga–Albert–Sudd system. In contrast, the r^2–lag curves in Section 3.4 show the lag at which the statistical association between Lake Victoria levels and downstream wetland extent is strongest. This clarification will help readers distinguish between the physical event propagation used to estimate transit time and the statistical lag relationships derived from correlation analysis.

1.7 The phrase "complex system with complex hydrology" appears multiple times in close proximity (opening paragraphs); please consider pruning or varying wording to avoid diluting a strong opening statement.

We will revise the Introduction to remove the repeated phrase and improve readability, while preserving the intended emphasis on the complex interconnected and storage-driven nature of the lake–river–wetland system.

1.8 Where you cite record Sudd extent (163,475 km² in 2022), place the number in the Abstract and include the six-year series for context (2019–2024).

We will revise the Abstract to include the maximum observed Sudd extent of 163,475 km² and briefly reference the sustained sequence of high wetland extents during 2019–2024 for context. This will help convey the scale and importance of the recent flooding events at the outset of the manuscript.

1.9 The terminology: "activation/backwater" is used appropriately; however, consider a one-line parenthetical definition at first use to help non-specialist readers.

We will add a brief parenthetical definition when these terms are first introduced. The definitions to be added are provided here:

Backwater effect: a hydraulic phenomenon where elevated downstream levels can impede outflow or reverse tributary flow, raising upstream water levels (Zhang et al., 2023).

Wetland activation: the onset of inundation and hydraulic connectivity within wetlands when inflow exceeds local wetland storage thresholds, allowing water to spread through previously dry or weakly connected wetland areas (Junk et al., 1989).

1.10 L42 & L45: (Mohamed et al., 2005b, 2005a) (I think it should be 2005a, 2005b). L59: (Mohamed et al., 2005a, 2005b). This approach should be adopted throughout the manuscript.

We will review and correct the ordering of these citations throughout the manuscript to ensure consistency.

1.11 Figures, especially 5, 6 & 7 are placed very far from where they are first mentioned in the manuscript. Considering moving figures closer to where they are first mentioned in the manuscript.

We will review the figure placement in the revised manuscript so that figures appear closer to where they are first discussed in the text. Final positioning will be handled during typesetting to ensure figures are placed appropriately relative to their first reference in the text.

References:

Junk, J. W., Bayley, B. P., & Sparks, E. R. (1989). *The flood pulse concept in river-floodplain systems*.

Zhang, X., Bi, Z., Sun, X., Wang, P., Xu, Z., & Jia, B. (2023). Backwater Effects in Rivers and Lakes: Case Study of Dongping Lake in China. *Water (Switzerland)*, *15*(21). https://doi.org/10.3390/w15213850