Response to Reviewers' Comments

Title: Suspended sediment dynamics in an urban, mountain catchment in Nepal

Authors: Rajaram Prajapati, Saroj Karki, Saraswati Thapa, Hanik Lakhe, Daniel J. Bain, John Gardner

----

We are thankful to the reviewers for their valuable comments on our manuscript. Below we respond to the comments and questions raised. Modifications and improvements are incorporated in the revised manuscript as mentioned below for each of the comments. For easy visualization, the responses to the reviewers' comments are provided below, and changes in the manuscript are in the track change form. Line numbers are used to refer to the changes made in the manuscript.

Response to Comments from Reviewer #1

Comment-R1: This study analyses the suspended sediment dynamics in a tributary of the Kathmandu valley, which is characterized by monsoonal rainfall patterns and experienced increased human pressure during the last decades. The study is based on a high resolution, sensor-based suspended sediment monitoring program with a focus on the analysis of monsoonal rainfall events. Unfortunately, the monitoring period, which covers six months, is rather short, given the high temporal variability of headwater catchments in monsoonal setting. Despite the short period, the authors were able to monitor a couple of discharge / sediment transport events, which were analyzed in terms of the seasonal(monsoonal) changes, which reflect antecedent rainfall and soil moisture conditions, that effects the runoff efficiency and sediment connectivity in the studied catchments. It provides interesting and valuable information and data in an area, with insufficient knowledge on sediment dynamics and strong human impacts due to mining and other land use activity. In this respect, the manuscript is very valuable for publication in HESS. However, in the current form, the manuscript has some limitations, which need to be addressed before publication (see general and detailed comments below).

Response-R1: We appreciate your encouraging words and have carefully considered your comments below as we have revised the manuscript.

Comment-R2: The discussion of the results remains in large parts at a very general level, analyzing the general link between rainfall pattern, hydrology and sediment transport dynamics. To increase the value of this publication, the results should be more strongly discussed in term of the particular situation (physical geography and recent urbanization dynamics) of the study site. For instance, the following questions could guide a more in-depth discussion:

- Which areas/locations in the study site are prone to erosion / sediment remobilization and what are the relevant processes / factors (e.g. topography vs. rainfall pattern vs land use pattern)?
- How are these areas located to the monitoring site (proximal, distal) and what could be there effect on the sediment hysteresis?
- Different types of mining exist in the area: sand mining within the river and large-scale mining at hillslopes. How are these areas connected to the river network and how do they influence the sediment dynamics / hysteresis?
- Much of the agricultural land use takes place in the lower part of the catchment. How does this contribute to the suspended sediment transport at the outlet, which seems to have the highest suspended sediment concentration in the catchment?

- What are the dominant internal/external driving factors controlling the observed dynamics and how will the likely evolve in the near future. Esp. how did the rapid urbanization in the area developed and what are expected future trends.

Response-R2: Thank you for these comments. We have added in more detailed information throughout results and discussion, including the locations of key mining sites and agriculture that are visualized in Figures 1 and 2. Further, we have revised several sections of the Discussion to more explicitly relate our interpretations to the Nakkhu catchment. These revisions include a stronger discussion of the spatial distribution of sediment sources, the role of the mid-catchment mining area and tributary inputs, and the dominant factors controlling sediment transport and future sediment dynamics in the study catchment, However, we are not able to resolve all of the details suggested. The relatively short period of sediment flux record, combined with other hydrologic records and land use mapping, ultimately limits the strength of the inferences we can make. We do not feel comfortable making strong inferences on the exact sediment sources, source to sink connectivity, or predicting the future in a region that is highly geomorphically active and being rapidly developed. Moreover, one of our goals is to also lay out the case for low cost sensor approaches that could be of interest to a wider community beyond fluvial geomorphology. We therefore believe that the revised level of interpretation is appropriate and well supported by the available observations, while maintaining the broader objectives of the manuscript. See specific comments R3, R6, R9, R29, R36, R37, R40, R46 below that address your overall suggestions.

Comment-R3: Furthermore, in-depth comparison with other studies on a similar topic is missing. For instance, with respect on event-based characteristics:
Uber, M., Beckers, L.-M., Terweh, S., Helmke, P., Hoffmann, T., 2025. Dynamics of rainfall, discharge, suspended sediment and micropollutant transport in the Moselle River, Central Europe. Environ Sci Europe 37, 204. https://doi.org/10.1186/s12302-025-01243-1

Skålevåg, A., Korup, O., Bronstert, A., 2024. Inferring sediment-discharge event types in an Alpine catchment from sub-daily time series. Hydrol. Earth Syst. Sci. 28, 4771–4796. https://doi.org/10.5194/hess-28-4771-2024

Response-R3: Thank you for this helpful suggestion. We have incorporated comparisons with the findings of Uber et al. (2025) and Skålevåg et al. (2024) in the Discussion to better place our results in the context of recent event-based studies.

P20/L408-412
Similar event-to-event variability has also been reported by Uber et al. (2025), who found that cumulative rainfall alone was insufficient to explain suspended sediment responses. Instead, rainfall characteristics, antecedent catchment conditions, and sediment availability collectively influenced SSC dynamics among storm events. Likewise, Skålevåg et al. (2024) showed that event magnitude and hydro-sediment characteristics provided greater discrimination among event types than hysteresis alone, emphasizing that multiple event-scale metrics are required to interpret suspended sediment dynamics.

P21/L442-445
While hysteresis provides valuable insight into sediment source activation and transport pathways, recent studies have shown that hysteresis alone is insufficient to distinguish sediment-discharge event types because similar loop patterns can arise from different hydrological and geomorphic processes (Skålevåg et al., 2024).

P21/L455-457

Our findings confirm that suspended sediment transport in the study catchment is highly event-driven, with extreme flood events accounting for a disproportionate share of the total sediment transport (Buendia et al., 2016; Fang et al., 2013; Ran et al., 2020a; Uber et al., 2025).

P22/L467-470

This concentration of sediment export within a narrow temporal window aligns with previous studies in steep, monsoon-influenced catchments, which show that 60% to 99% of annual sediment load can be transported during a few large flood events (Buendia et al., 2016; Oeurng et al., 2010; Russel et al., 2019; Leyland et al., 2017; Liu et al., 2023; Ran et al., 2020a; Ran et al., 2020b; Uber et al., 2025).

Comment-R4: In terms of high-resolution data on sediment dynamics and the inference of suspended sediment loads, the following references should/could be cited:
Moatar, F., Person, G., Meybeck, M., Coynel, A., Etcheber, H., Crouzet, P., 2006. The influence of contrasting suspended particulate matter transport regimes on the bias and precision of flux estimates. Science of The Total Environment 370, 515–531. https://doi.org/10.1016/j.scitotenv.2006.07.029

Slabon, A., Hoffmann, T., 2024. Uncertainties of Annual Suspended Sediment Transport Estimates Driven by Temporal Variability. Water Resources Research 60, e2022WR032628. https://doi.org/10.1029/2022WR032628

Response-R4: Thank you for your suggestions. We have incorporated the recommended references at the relevant locations in the revised manuscript.

P2/L42-45

Capturing relevant sediment transport dynamics in urban mountain catchments requires high-resolution monitoring (Moatar et al., 2006; Slabon and Hoffman, 2024), as runoff and sediment fluxes can shift dramatically within hours.

P22/L492

Accurately capturing these episodic dynamics requires high-frequency monitoring (Moatar et al., 2006; Oeurng et al., 2010; Pillo et al., 2023; Slabon and Hoffman, 2024).

P23/L504-507

A gradual decrease in estimated sediment load with coarser temporal resolution (Fig. 8) highlights the limitations of low-frequency monitoring, which tends to miss short-lived but sediment-rich events particularly during flashy flood events common in steep, urbanizing catchments (Francalanci et al., 2013; Moatar et al., 2006; Safdar et al., 2024; Slabon and Hoffman, 2024).

Comment-R5: Line 60-63: „during the September 2024 flood-triggered by record-breaking rainfall-which led to landslides“ -> confusing sentence, please rephrase
Response-R5: Thank you for pointing this out. We have rephrased the sentence as per your comment.

P3/L65-68

This growing vulnerability was further demonstrated during the September 2024 flood, which was triggered by record-breaking rainfall and caused widespread landslides, inundated settlements, damaged *infrastructure, and extensive channel alteration and sediment deposition along river corridors and floodplains (Lamichhane et al., 2025).*

Comment-R6: Line 73: If monsoon dynamics are a central part of the analysis, I suggest to give more details on sediment dynamics driven by monsoon in this area.
Response-R6: Thank you for your suggestion. We have added the following context in the text.

P2/L51-56
Approximately 80% of the annual rainfall in the Kathmandu Valley occurs during the summer monsoon (June–September) (Shrestha et al., 2023). During this period, Himalayan rivers transport an estimated 90–95% of their annual suspended sediment load, with intense monsoon storms rapidly mobilizing sediment from hillslopes, landslides, riverbanks, and anthropogenically disturbed catchments (Lupker et al., 2012; Morin et al., 2018). These highly episodic sediment transport processes occur over timescales of hours to days, highlighting the need for high-frequency monitoring to accurately characterize monsoon-driven sediment dynamics.

Comment-R7: Line 79: Start with description of the location and physical geography and continue with LU-change afterwards. If the Nakkhu is a hot spot of urbanization, and if this is a major fact for this study, this should be highlighted in the intro to motivate the study.
Response-R7: The Study Area section has been reorganized as per your suggestion. We also added a sentence in the Introduction to explicitly identify the Nakkhu River catchment as an example of the broader urbanization and anthropogenic pressures affecting the Kathmandu Valley and to better motivate its selection as the study area.

P3/L87
The Nakkhu River catchment, located in the southern part of the Kathmandu Valley in central Nepal, drains approximately 52.3 km^2 (Fig. 1). The river originates in the southern hills at an elevation of around 2540 m above sea level and flows northward for 26 km before joining the Bagmati River. The catchment has an elongated shape, characterized by steep upper reaches and a relatively narrow downstream section (Fig. 1(e)), and an average channel gradient of 5.2%, and consequently has a dynamic flow regime (Maharjan and Tamrakar, 2010). Its steep terrain, highly dynamic channel, and exposure to both natural and anthropogenic disturbances make it particularly susceptible to upstream erosion, downstream sedimentation, and variations in sediment flux (Maharjan and Tamrakar, 2010). The upper catchment experiences …

Comment-R8: Line 83: Indicate that major flow is from S to N
Response-R8: Thank you. We have revised the sentence.

P3/L88-89
The river originates in the southern hills at an elevation of around 2540 m above sea level and flows predominantly from south to north for 26 km before joining the Bagmati River.

Comment-R9: Line 86: Sand mining is typically done within the river itself. You should give more information in the mining activities in the Nakkkhu River catchment, as this seems to be central to understand sediment dynamics. Only in Fig 9. Is becomes obvious that there is hillslope and channel (sand) mining. Pictures in Fig.9 are very helpful to understand the human impact in that catchment and should be shown much earlier. It is also important to locate these areas (Fig.1) and describe the relation to the “synoptic” sampling.

Response-R9: We agree that the term “sand mining” was ambiguous. To improve clarity, we have replaced it throughout the manuscript with more specific terminology distinguishing the dominant hillslope mining and aggregate extraction activities from localized in-channel sand and gravel extraction. We have also expanded the Introduction and Study Area descriptions to better characterize mining activities in the Nakkhu River catchment and their potential influence on sediment dynamics.

P3/L68-71
The Nakkhu River catchment reflects many of these ongoing changes, including rapid urban expansion, floodplain encroachment, hillslope disturbance, and intensive hillslope mining, providing an opportunity to investigate event-scale sediment dynamics in an urbanizing mountain watershed of the Kathmandu Valley.

We have moved Fig. 9 earlier in the manuscript (now Fig. 2). Location of hillslope mining and synoptic sampling sites have already been shown in Fig. 1c. The photographs in Fig. 9(b)–(d) illustrate features that occur at multiple locations within the downstream reach below the confluence (e.g., landslides, in-channel sand and gravel extraction, and sediment deposition) rather than single, unique sites. Because these features are spatially clustered near the confluence, adding separate location markers would result in overlapping symbols and reduce the clarity of the figure. We have clarified in the figure caption that panels (b)–(d) depict areas located downstream of the confluence.

Comment-R10: Line 91: Are temperatures given as catchment average, or certain location within the catchment?
Response-R10: The text has been revised to clarify that the reported temperatures represent catchment-average conditions.

P4/L101
Average temperatures across the catchment range between 28–30°C, while winter temperatures can drop to around 0°C (Ishtiaque et al., 2017; Prajapati et al., 2021a).

Comment-R11: Fig. 1: Show elevations in 1b and slope in 1c or used shaded relief to represent hillslope gradients in the catchment. Clearly indicate the location of the monitoring station used in this study in Fig 1c.
Response-R11: Thank you for this suggestion. We have revised Fig. 1 accordingly. Panel (b) now presents the Digital Elevation Model (DEM) of the study area, while panel (d) uses a hillshade-enhanced DEM to better illustrate hillslope gradients. We have also clearly identified the locations of the rainfall stations, sediment monitoring stations, synoptic sampling sites, and active hillslope mining areas in Fig. 1(d).

Comment-R12: Line 105: Indicate the time period for which Q and OBS is measured. The authors write that they measure SSC three time a week, but in Fig 2a, only 14 SSC measurements are shown. Furthermore, sediment station in Fig 1c show those station sampled during the synoptic campaign. However, where is the station located that is used in this study to analyse the events during the six months.
Response-R12: The OBS and discharge monitoring periods were clarified in the Methods section. Regarding the number of calibration samples shown in Fig. 2a, the manuscript already included a paragraph describing the challenges associated with OBS deployment, including ambient light

interference during low-flow conditions, biofouling, and debris accumulation, which resulted in the exclusion of low-flow observations and several unreliable periods. To avoid confusion, we further clarified in the figure caption that only reliable flood-event observations (n = 14) were retained for calibration.

P6/L121

We collected high-resolution rainfall, discharge, and SSC data from May to October 2023.

Comment-R13: Line 106: 30min intervals of tipping bucket means that you count the number of tips within 30min?

Response-R13: Yes. Rainfall was recorded using a tipping bucket rain gauge with a resolution of 0.2 mm per tip. The reported 30-minute rainfall values represent the cumulative rainfall recorded within each 30-minute interval. We have clarified this in the manuscript.

P6/L121-122

Rainfall was monitored at 30-minute intervals using two tipping bucket rain gauges (0.2-mm resolution; Fig 1(c)).

Comment-R14: Line 110: How well is the Q~h relationship described by the measurements? This is crucial to evaluate the quality of the results and should be discussed.

Response-R14: We agree the quality of the stage-discharge relationship is important for evaluating the discharge estimates. To address this comment, we revised the manuscript to report the number of discharge measurements used to develop the rating curve and the associated goodness-of-fit statistic (R^2 = 0.57).

P6/L125-126

The rating curve was developed from nine discharge measurements collected during the monitoring period (R^2 = 0.57).

Comment-R15: Line 116: Specify the fabricate and type of the filter and of the OBS sensor. Indicate wavelength of the light and scattering angle of the sensor. Is the sensor calibrated using formazine standards?

Response-R15: Thank you for the suggestion. We revised the manuscript to specify the filter and OBS used for SSC measurements. We revised the manuscript to include additional specifications of the OBS sensor. The sensor uses a near-infrared emitter with a peak wavelength of 890 nm and measures backscattered light at an approximate scattering angle of 180°. These details have now been added to the Methods section. The OBS sensor was calibrated directly against gravimetrically determined SSC measurements collected from the study catchment rather than using formazine standards, as the objective was to establish a site-specific relationship between sensor response and suspended sediment concentration.

P7/L132-138

SSC was determined gravimetrically by filtering water samples through a 47 mm diameter, 0.45-micron nylon membrane filter, drying at 105°C, and weighing the retained sediment (Eaton and Clesceri, 1995). An open-source OBS sensor developed by Langhorst et al. (2023) was mounted on a bridge pier near the streambank at a depth of approximately 0.2 m from the bed to ensure submersion across varying flow *conditions. The OBS sensor emits infrared light with a peak wavelength of 890 nm and detects the intensity of backscattered light from suspended particles in the water. The sensor geometry results in an approximate backscatter angle of 180°. Thus, measured backscatter is then calibrated to estimate continuous SSC using a regression model.*

Comment-R16: Fig 2: in (a) only 14 measurements are shown in contrast to (b) where you show much more measurements. Please indicate how much sample are taken overall. In (b) the shaded region represents the 95% confidence interval but many data points (more than 50%) are outside of the interval. I assume that the approach to estimate the CI is not reliable.
Response-R16: We apologize for the confusion. The 14 samples shown in Fig. 3(a) represent only the subset of SSC observations that were paired with reliable flood-event OBS measurements and were therefore used to calibrate the OBS sensor. In total, 68 SSC samples were collected during the study period and were used to develop the SSC-discharge relationship shown in Fig. 3(b). We clarified this distinction in the figure caption.

Thank you for pointing this out. The shaded region represents the 95% confidence interval of the fitted mean regression, obtained through Monte Carlo sampling of the uncertainty in the fitted regression coefficients (using the covariance matrix). Consequently, it is not expected that 95% of the measured data points fall within the shaded region. We have clarified this distinction in the figure caption to avoid confusion.

Comment-R17: Line 153: May to Oct. 2023 -> should be state at beginning of section 2.2.
Response-R17: Thank you for your suggestion. We have stated that at the beginning of section 2.2.

Comment-R18: Line 155: Database of 9 events! Do you need a DB for such a low number of events?
Response-R18: We used the term "database" to refer to the compilation of event-scale variables extracted for each flood event. To avoid overstating the size of the dataset, we revised the text and replaced "database" with "dataset." P8/L176 and L183

Comment-R19: Line 174-184: Testing the effect of the temporal resolution of the sampling intervals on the calculated sediment loads is strongly dependent on the subsampling of the SSC values/measurements. It is not clear from the description of the paragraph how this was done. The authors use for sub-daily sampling the SSC derived from OBS and for larger intervals the SSC measurements. This may introduce bias between both datasets. Furthermore, the authors apply the sediment rating curve approach, however, if high-res data are available not rating curve is needed. A similar study is done by Slabon and Hoffmann. Here subsampling was done using random selection from the high-res OBS data. A similar approach should be used here.
Slabon, A., Hoffmann, T., 2024. Uncertainties of Annual Suspended Sediment Transport Estimates Driven by Temporal Variability. Water Resources Research 60, e2022WR032628.
https://doi.org/10.1029/2022WR032628
Response-R19: Thank you for this important comment. We agree that the description of the temporal-resolution analysis was unclear and could be interpreted as comparing different SSC datasets across sampling intervals. We have revised the Methods section to clarify the procedure.

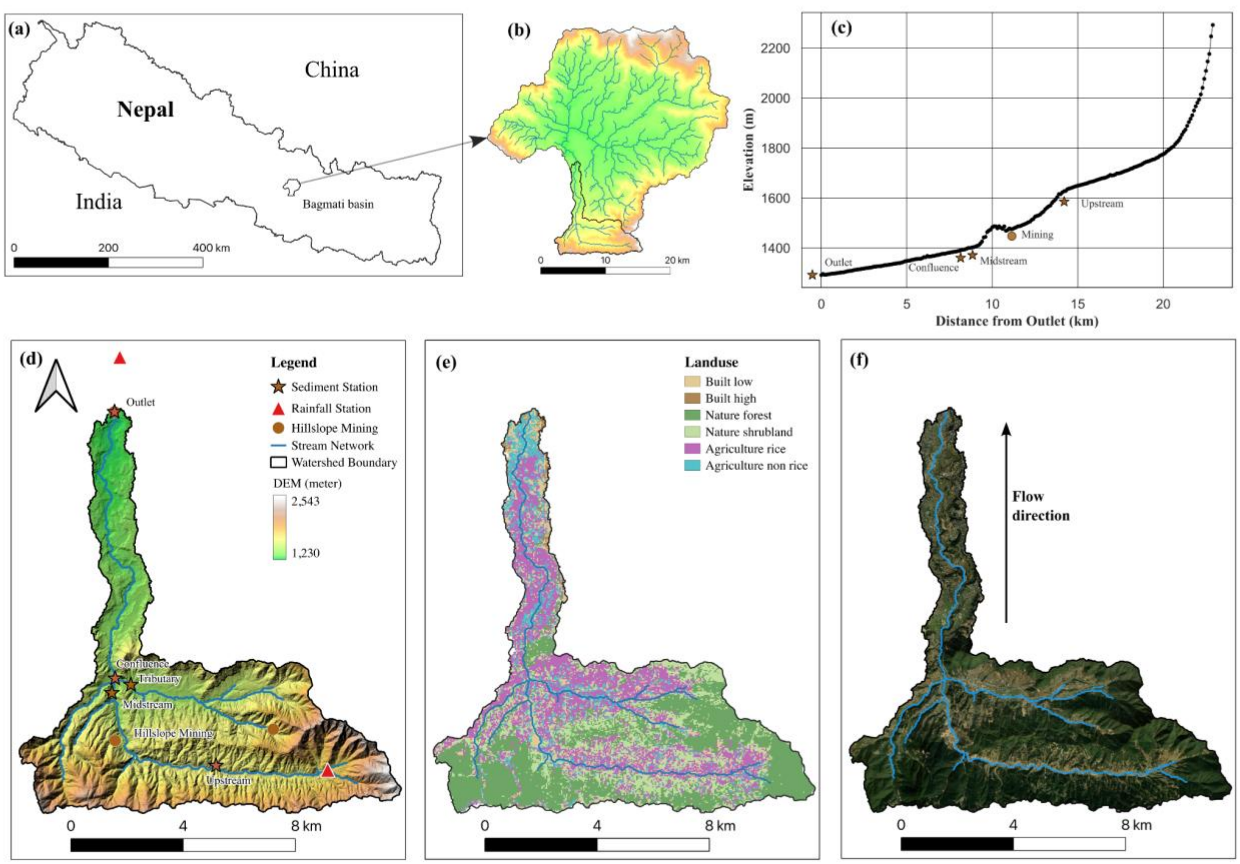
For the nine flood events with reliable OBS measurements, sediment loads were calculated using high-frequency SSC estimates derived from optical backscatter data. For periods where reliable OBS measurements were unavailable, including non-event periods and seven flood events, SSC was estimated using an SSC–discharge rating curve. To evaluate the effect of temporal resolution, discharge records were aggregated to different timescales (half-hourly to monthly), and SSC was estimated at each timescale using the SSC–discharge rating curve applied to discharge aggregated at the corresponding interval. Sediment loads were then recalculated and compared across temporal resolutions.

We acknowledge that this approach differs from that of Slabon and Hoffmann (2024), who evaluated sampling-frequency effects through subsampling of a continuous high-resolution SSC record. We have cited this study in both the Methods and Discussion sections for comparison. Because reliable OBS-derived SSC measurements were only available for nine flood events, we did not have a continuous high-resolution SSC record for the entire study period and therefore adopted the rating-curve-based approach described above. We have clarified this methodology in the revised manuscript.

P9/Section 2.5/L186-204

Comment-R20: Line 216: please indicate the location of the site in Fig. 1
Response-R20: The locations of the synoptic sampling sites are already shown in Fig. 1 as “Sediment Stations”. To improve clarity, we revised the text to explicitly refer readers to Fig. 1 for the locations.

Revised Fig. 1



Comment-R21: Line 228: Use “:” instead of “-“ -> “…were analysed: 1 in pre-monsoon and 8 in monsoon…”

Response-R21: Thank you for your suggestion. We have revised it.

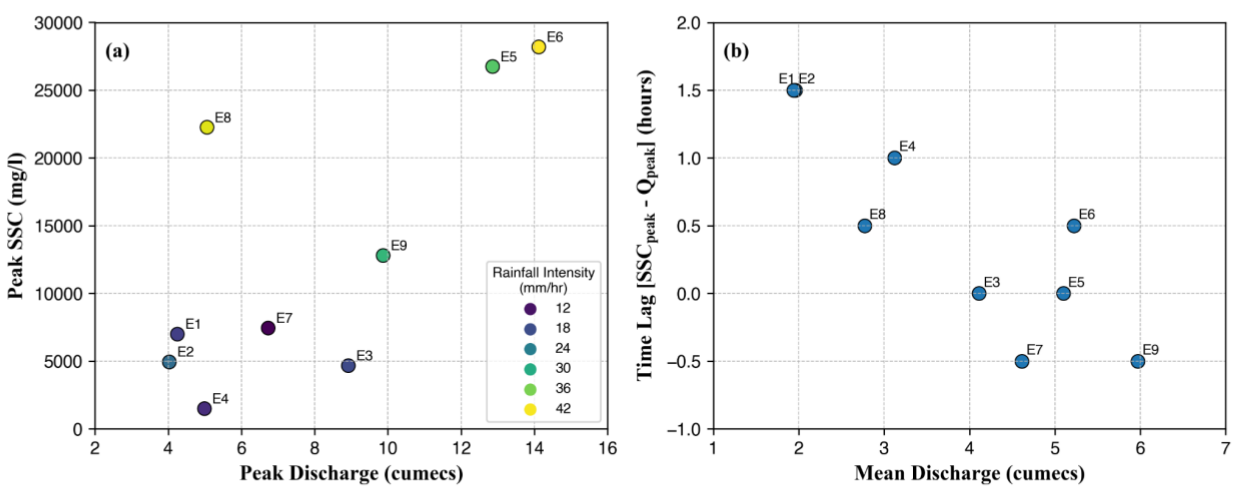
Comment-R22: Line 233: indicate number of events in Fig 3 (EX)
Response-R22: Thank you. We have mentioned the Event number in the text. P11/L256

Comment-R23: Line 252: "consistent evolution of hysteresis" -> what do you expect how this evolved? This should be explained (for instance in the intro).
Response-R23: Thank you for this comment. We agree that the expected seasonal evolution of hysteresis patterns was not explicitly introduced earlier in the manuscript. To avoid ambiguity, we revised the text and removed the phrase "as expected". The revised sentence emphasizes the observed relationship between hysteresis behaviour and antecedent and event-scale hydrologic conditions rather than an anticipated seasonal progression.

P12/L276
We did not find a consistent evolution of SSC-Q hysteresis from pre-monsoon to late monsoon; instead, observed hysteresis patterns and event-scale SSC dynamics were related to antecedent and event hydrologic conditions.

Comment-R24: Fig. 4: Events could be labeled in the Figure, as the number of events is rather low.
Response-R24: Thank you for your suggestion. We have revised the figure 5.

Revised Fig. 5



Comment-R25: Line 290: From Fig A1 it is hard to see for which event downstream rainfall contributions were higher/lower.
Response-R25: The intended reference was Fig. 5(d). We have corrected the figure citation. Thank you.

Comment-R26: Line 297: How did the authors calculate the runoff coefficient? This requires some inter-/extrapolation of the rainfall data from the two met stations to the catchment. Please describe how this was done.
Response-R26: We agree that the calculation of runoff coefficient would require additional methodological description. Because runoff coefficient was not used elsewhere in the analysis and was

only mentioned to support the interpretation of Event 2, we removed the reference to runoff coefficient and revised the text accordingly.

P14/L321
The event had the lowest antecedent rainfall (P3=1.4 mm) and initial discharge (0.87 m^3/s), resulting in high infiltration losses.

Comment-R27: Tab.1: I suggest to add the runoff coefficient of the events to the table.
Response-R27: We appreciate this suggestion. However, runoff coefficient was not a primary variable used in our analysis and was only briefly mentioned in the discussion of one event. To avoid introducing an additional metric that would require further methodological description and interpretation, we removed the reference to runoff coefficient from the manuscript and therefore did not add it to Table 1.

Comment-R28: Fig. 6: 80% of suspended sediment transport in less than 10% of the time, this is comparable to other rivers. See for instance Slabon and Hoffmann (2024, WRR)
Response-R28: Thank you for this suggestion. We agree that the highly episodic nature of sediment transport observed in our study is consistent with findings from other river systems. We have added a reference to Slabon and Hoffmann (2024) and briefly discussed this similarity in the revised manuscript.

P15/L337-339
Similar behavior has been reported in other river systems, where more than 80% of suspended sediment transport can occur within less than 10% of the observation period, highlighting the strong temporal concentration of sediment flux during high-flow events (Slabon and Hoffmann, 2024).

Comment-R29: Line 338: You refer the first time to the location of the mining site here in this text. The locations of the mines and the sand mining area should be explained in the intro of the study site and be explained in context of the synoptic sampling along the river network (line 216ff).
Response-R29: Thank you for this suggestion. We agree that the locations of the major mining areas and their relationship to the synoptic sampling network should be introduced earlier in the manuscript. We revised the Study Area section to describe the presence of active hillslope mining areas within the catchment, added their locations to Fig. 1, and updated the figure caption accordingly. We also clarified in the Methods section that the synoptic sampling sites were selected to capture major sediment source and transport zones, including reaches located upstream and downstream of the mining areas, tributary confluences, and the catchment outlet.

P4/L95-97
Several active hillslope mining sites are located in the mid- and upper catchment (Fig. 1(d)), where they are directly connected to the river network through tributary channels and may act as important sediment source areas during storm events.

P10/L237-239
*The sampling sites were selected to capture major sediment source and transport zones within the catchment, including reaches located upstream and downstream of active hillslope mining areas, tributary confluences, and the catchment outlet (Fig. 1(d))***.**

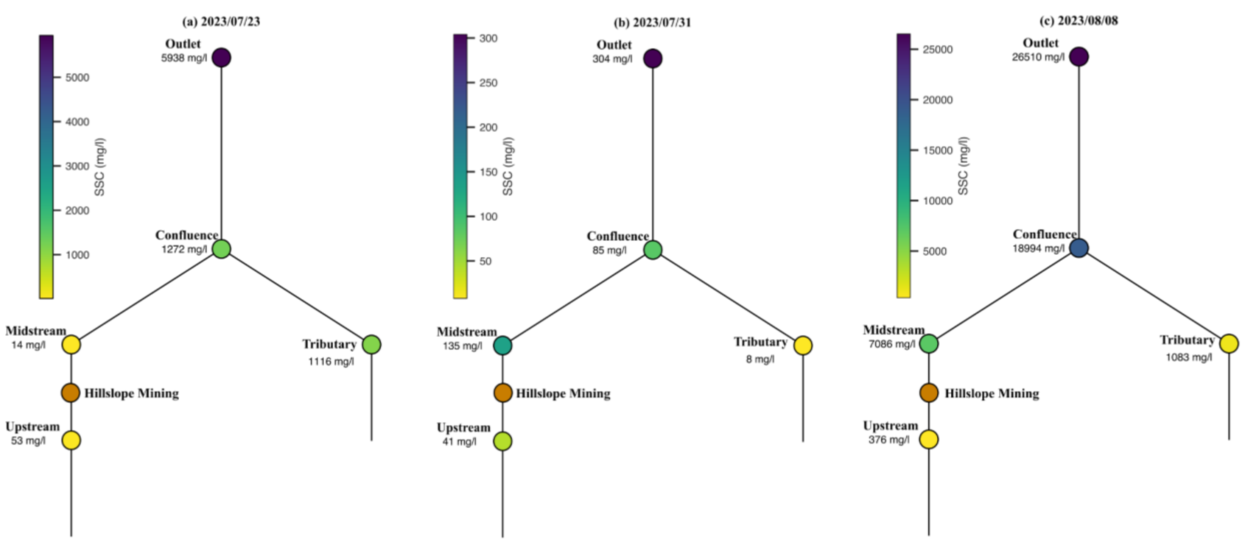
Comment-R30: Line 348: The area of sediment remobilization downstream of the confluence is impacted by disturbances of in-channel sand mining. Please clearly indicate this link here!

Response-R30: Thank you for this comment. We agree that the role of localized in-channel sand mining in the downstream reach was not sufficiently explicit. We revised the text to clarify that the observed remobilization of stored sediment near the outlet may also be influenced by disturbances associated with in-channel sand mining activities.

P18/L372
Higher SSC at the outlet compared to the upstream confluence, along with longitudinal grain size patterns and field observations of in-channel sediment bars and depositional features and localized in-channel sand mining activities along the main-stem (Fig. 2(d) and Table A1), suggest episodic remobilization of stored sediment from in-channel sediment sources in the urban-impacted main-stem located near the outlet.

Comment-R31: Fig. 8: The authors should locate the mining activities in these graphs!
Response-R31: Thank you for this suggestion. We have revised Fig. 9 to explicitly indicate the location of the active hillslope mining area along the mainstem. The figure caption has also been updated to clarify the relationship between the mining site and the synoptic SSC sampling locations.

Revised Fig. 9



Comment-R32: Fig. 9d: I don't see massive sediment accumulation in this Figure. Deposited material in front of the bridge (right side) seems to be artificial dumping!
Response-R32: Thank you for this observation. We agree that the photograph does not clearly demonstrate extensive sediment accumulation. The image is intended as a representative example of in-channel sediment deposition observed downstream of the confluence, while the large material pile on the right is construction-related earth material. We have revised the figure caption to clarify this distinction.

Comment-R33: Line 367: Add runoff efficiency to Tab. 1
Response-R33: Thank you for your suggestion. As mentioned earlier, we removed the reference to runoff coefficient and revised the text accordingly.

Comment-R34: Line 369: remove "or in-stream sediment deposits" -> these can be rapidly mobilized, leading to clock-wise hysteresis, if no threshold effects are involved.
Response-R34: We have removed the phrase as per your suggestion.

Comment-R35: Line 404: "…early upstream-driven peaks and later downstream-driven peaks…" -> is this a general pattern? If yes, could this be detected in many events connected with a typical hysteresis pattern and is this pattern connected to certain precipitation events / weather pattern?
Response-R35: Thank you for this comment. Our intention was to describe the behaviour observed during Event 9 rather than imply a general hysteresis pattern. We revised the text to clarify that the interpretation is specific to this event and reflects the spatial distribution of rainfall during this particular event.

P20/L430 - P21/L432
During this event, early upstream-driven peaks carried high sediment loads, while later downstream-driven peaks produced increased discharge but diluted SSC, likely due to limited sediment availability in downstream areas.

Comment-R36: Line 409-410: This is a very general statement, could this be made more specific with respect to the study site? What are general sources and where are these located? Which part of the catchment is more prone to erosion and how is this affected to the human impact in the area?
Response-R36: Thank you for this helpful comment. Section 4.1 focuses on the interpretation of event-scale sediment transport processes based on hysteresis and hydrological response, whereas the spatial distribution of sediment sources and their relationship to observed SSC patterns are examined in detail in Section 4.3 using the synoptic sampling and grain-size data. We believe this organization avoids repetition while separating process interpretation from spatial source characterization.

Comment-R37: Line 419-421: Again, very general -> be more specific to the study area. What are main driving factors affecting future dynamics in the study site?
Response-R37: Thank you for this helpful comment. We have revised this section to make the discussion more specific to the Nakkhu catchment by explicitly identifying the dominant factors controlling sediment dynamics. Please check section 4.1

Comment-R38: Line 423: The authors highlight the importance of intense storm events for the sediment transfer and export from the studied catchment. A more detailed analysis of return intervals of relevant flood magnitudes should be conducted. How often do sediment transport events occur during a year?
Response-R38: We agree that the frequency and recurrence of sediment transport events are important for understanding long-term sediment dynamics. However, the present study is based on a single monsoon season and nine analyzed events, nor does this catchment have long-term discharge monitoring, which does not provide a sufficient record for robust flood frequency or return interval analysis. Because the objective of this study was to investigate event-scale sediment transport processes and their controlling factors, we did not undertake a return interval analysis.

Comment-R39: Line 438: Does the 420 t/km2 refer to the six month or the annual load (i.e. 420 t/km2/a)? Please clarify. Comparison of the load from the six months with other study site requires consideration of the very strong interannual variability of these systems, depending on rain conditions of each year. Was the monitoring period a rather dry, normal or wet period?

Response-R39: Thank you for this comment. We clarified that the reported sediment yield of 420 t km^{-2} represents the six-month monitoring period (May–October 2023) rather than an annual sediment yield. We agree that sediment yields can exhibit substantial interannual variability due to differences in rainfall magnitude and event characteristics. The comparison with annual yields from other catchments was intended to provide context on the magnitude of sediment export, as the monitoring period largely coincided with the monsoon season, during which more than 80% of annual rainfall occurs and most sediment transport takes place. To provide additional context, we have added text noting that the 2023 monsoon season was classified as below normal in the southern part of Kathmandu Valley, where the Nakkhu catchment is located. We have also clarified that the reported sediment yield reflects this below-normal monsoon season and should not be interpreted as a long-term average annual sediment yield.

P22/L471-474

Based on six months of high-frequency monitoring, the study catchment's sediment yield was 420 ton/km^2 during the monitoring period, placing it on par with or exceeding annual yields reported in several high-yield Mediterranean catchments such as the Isábena (445 km^2; 530 ton/km^2; López-Tarazón et al., 2012) and the Asses (657 km^2) and Bléone (905 km^2) rivers (383 ton/km^2; Mano et al., 2009).

P22/L481-483

According to the Department of Hydrology and Meteorology Nepal, the 2023 monsoon season was classified as below normal in the southern part of Kathmandu Valley, where the Nakkhu catchment is located.

Comment-R40: Line 476-484: Again, this is very general, and it would be nice to more strongly work with the results from the study. Where are the major mining areas? Is there location related to increased SSC? Etc…

Response-R40: Thank you for this helpful suggestion. We have revised this section to more directly incorporate the synoptic sampling results by identifying the mid-catchment mining area as a major sediment source zone and highlighting the observed increase in SSC downstream of the mining area and at major tributary confluences.

P23/L514-525

Synoptic sampling revealed clear spatial differences in grain size and SSC patterns along the river network, with the largest increases in SSC observed in the mid-catchment downstream of the active mining area and at major tributary confluence. These spatial patterns are shaped by both geomorphic setting and human activities. Steep hillslopes with unprotected earthen roads (Fig. 2(b)), mining activities (Fig. 2(a) and Fig. 2(c)), widespread landslides (Fig. 2(b); Khatakho et al., 2021), and unregulated foothill excavation for housing developments without slope stabilization in the upper catchment contribute to sediment generation, particularly during high-intensity storms. The major mining areas are concentrated in the mid-catchment, where synoptic sampling consistently indicated elevated SSC, suggesting these sites as important sediment source zones. Additionally, the tributaries, characterized by steep gradients, carry substantial sediment loads that are deposited at their confluence with the main river, forming debris fans, which were observed during the September 2024 flood in the study catchment (Lamichhane et al., 2025). Although 47% of the catchment is forested (Zanaga et al., 2022), with most of this cover concentrated in the upstream region (Fig. 1(e)), these areas remain highly vulnerable to erosion due to steep slopes, poor slope stability and localized human disturbances.

Comment-R41: Line 487: Awkward sentence (haphazard landad????)
Response-R41: Thank you for pointing this out. We corrected the typological error.

Comment-R42: Line 490ff: Finally, the authors give more details on the questions I raised above. I am wondering, if these info's can be given earlier in the MS.
Response-R42: Thank you for your suggestion. We have revised sections 4.1 and 4.3 to incorporate the main findings from our synoptic sampling earlier in the discussion.

Comment-R43: Line 496-498: While the grain size decreases the overall SSC strongly increases down to the outlet, suggesting remobilization of fines in the same reach. This is in contrast to the "…diminished transport capacity…" stated by the authors in relation to the fine sediments (line 501-502). Please rephrase!
Response-R43: Thank you for this helpful comment. We agree that the original wording was potentially misleading. We have removed the phrase regarding diminished transport capacity to avoid this inconsistency and improve clarity.

Comment-R44: Line 511: "rapidly urbanizing mountain catchment" -> can you give numbers of this development. This would be helpful to extend the discussion toward expected changes of sediment transport dynamics.
Response-R44: Thank you for this suggestion. We added quantitative context to support the description of the catchment as rapidly urbanizing. Previous studies have shown that built-up areas in the Kathmandu Valley increased by more than 400% between 1989 and 2016 (Ishtiaque et al., 2017), reflecting the rapid urban expansion and land-use change occurring across the region. We incorporated this information into the revised manuscript.

P24/L551-553
This study provides the first high-frequency, event-scale assessment of suspended sediment transport in a rapidly urbanizing mountain catchment of the Kathmandu Valley, where built-up areas have expanded by more than 400% over the past three decades (Ishtiaque et al., 2017).

Comment-R45: Line 516: "limited sediment availability in downstream reaches" -> this again is in contrast with the strong increase of SSC from the confluence to the outlet (Fig.8).
Response-R45: Thank you for this observation. We agree that the original wording could be interpreted as inconsistent with the downstream SSC patterns shown in Fig. 8. We have removed the phrase "limited sediment availability in downstream reaches" to improve consistency between the Conclusions and the interpretation of our results.

Comment-R46: Line 527: sediment hazards -> please specify the most important hazards in the study area
Response-R46: Thank you for this suggestion. We revised the text to specify the key sediment-related hazards relevant to the study area, including channel aggradation, reduced channel conveyance capacity, and infrastructure damage during extreme events.

P24/L572-575
Such targeted interventions are vital to reducing sediment mobilization during extreme events, averting sediment hazards such as channel aggradation, reduced channel conveyance capacity, infrastructure

damage during extreme events, and consequently strengthening the flood resilience of urban mountain watersheds.