Review Report for

Nested, Reach-Scale Fluvial Sediment Budgets Quantify Watershed Sediment Transport Pathways

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Paper DOI: 10.59236/geomorphica.v2i2.56

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Round 1 Review

Comments by reviewer 1 (anonymous)

Completed: 2025-09-18 03:59 pm
Recommendation: Major revisions

For author and editor

The Corresponding Author,

Thank you for this insightful paper. The approach and idea are quite intriguing. I have a few concerns, particularly regarding the methodology (see below).

Comments:

What is the current state of knowledge on sediment source(s) determination? And why is it relevant, especially within the study area?

Introduction

Lines 91 – 99...this looks more like methodology

Lines 85 – 87: The reason behind nested sediment budgets is not fully justified compared to other available choices.

Methodology

Headwater streams, definition?

Why 2008 aerial imagery for channel banks upstream? Any validation for the 140 stream channels?

Lines 212 – 220: Williamson's (2013) approach, as reported by Pizzuto et al. (2014), represents an attempt to estimate suspended sediment fluxes across ungauged tributaries. Scaling the resulting flux (361 ± 77 Mg/yr) by drainage area provides a straightforward means of generalizing the findings to other tributaries. However,

Sediment rating curves are highly site-specific, and their transferability is limited given the strong influence of local land use, geology, and storm dynamics on sediment transport.

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The extrapolation of fluxes to ungauged tributaries using empirical stream length–area relationships introduce further uncertainty, yet the cumulative error associated with these steps is not fully quantified.
While the method is transparent as a first-order regional estimate, its underlying assumptions may oversimplify spatial variability in sediment dynamics, and the results should be interpreted with appropriate caution.
Lines 232 – 245: Karwan et al. (2018) and Rose and Karwan (2018a, 2018b) provide an important contribution by applying geochemical fingerprinting and mass balance to stormflow samples at the WCC Tributary above London Grove.

Some concerns:

The relatively frequent recurrence interval of this threshold (0.93 months, or 29 days) underscores the role of regular storm events in mobilizing upland sources. However, the subsequent partitioning of annual flux using Williamson's (2013) rating curve as a purely binary discriminator raises methodological concerns such as , assigning 100% of sediment below the threshold to river corridor (bank erosion) sources and 100% above the threshold to upland sources oversimplifies sediment dynamics and neglects potential mixing under intermediate flow conditions.
Sediment provenance is rarely dichotomous; contributions from both sources are likely to co-occur across a range of discharges, with proportions varying by season, antecedent conditions, and storm magnitude.
While the binary approach provides a tractable means of integrating the fingerprinting results into flux estimates, it may misrepresent source contributions and underestimate uncertainty.

Lines 284: Based on field observations…where?

Lines 393 – 400: I acknowledge the idea behind this method. However, the method's reliability depends strongly on the accuracy and temporal representativeness of the local sediment budgets. Storage and remobilization processes are highly dynamic, responding to flood magnitude, vegetation, and geomorphic adjustments; assuming fixed fractions may mask this variability. Moreover, while the approach can quantify long-term average contributions, it may not fully capture episodic sediment pulses or lag times associated with floodplain storage and re-entrainment. Despite these limitations, the framework is a rigorous and conceptually clear way to integrate source attribution with downstream connectivity, provided the uncertainties associated with local budget estimates are carefully constrained.

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Comments by reviewer 2 (anonymous)

Completed: 2025-10-16 08:02 PM
Recommendation: Minor revisions

For author and editor

see attached comments

In general, the manuscript is well written and organized which made the review go smoothly for a complicated subject matter. The methods were clearly explained except for some clarifications noted below. I learned much about addressing uncertainty in corridor erosion and deposition estimates. References were adequate, except it would be good to reference Reid and Dunne 2016 for an example of the breadth of sediment budget components. Supplemental materials were necessary to assess the methodology. The findings of the paper should be of high value and significance to other scientists working on similar issues as well as land/water managers and planners. Tables and figures in the manuscript and in the supplemental materials were needed. None seemed superfluous.

Title: The Title is a little long and perhaps “river channel sediment budgets” doesn’t adequately reflect the floodplain deposition portion of the budget. Maybe something like “Watershed pathways of suspended sediment relative to streambank and hillslope sources and floodplain storage”.

Abstract: Reads well, is concise, and reflects major points of the publication.

Non-technical summary – Last sentence could use some less technical wording.

Methods – The methods are described well but the supplemental text, figures, and tables were needed to understand the details needed to gain confidence in their methods.

Conclusions: adequate – see next paragraph for an additional relation that could be discussed more.

Sediment sources – It is not mentioned in this paper but there could be some reference to how sediment sources are considered in watershed water quality models used for land management and sediment reductions. (This is a suggestion). These models typically do not include bank erosion directly, or network/reach storage directly (ie. SWAT etc.) and overestimate upland soil erosion in order to balance the observed flux at the watershed outlet. The watershed water quality models and resulting Total Maximum Daily Load reductions drive land management and focus in on reducing soil erosion from agricultural/cleared land. Hopefully more publications like this showing the importance of gullying and bank erosion and eventually linked to upland hydrologic alterations that can lead to increased incision, widening, and lateral migration (increases in meander belt width) will be helpful for

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really zeroing in on where land management can make the biggest impact. Any additional discussion points you can raise about how much corridor erosion has been increased due to changes in hydrology would be helpful.

Comments by general line number below with relevant inserts from supplementary materials.
122 – Land use/land cover – It would be helpful to know the proportions of ag/forest/wetland in the watershed and if they are concentrated in one area more so than others depending on the geology and topography.

175-188 Sediment budget components – In addition to floodplain storage there are other areas of deposition with different time scales of transport -- there are "overbank" storage areas associated with ravines and gully systems and tributary fans, which generally accumulate sediment during episodic runoff events (Reid and Dunne, 2016, fig. 16.1 in Tools in Fluvial Geomorphology). [Reid and Dunne 2016 is out of order in the reference list.] Please clarify if you are including these other depositional features in your floodplain group, or that you haven't accounted for those. Thank you for noting the lack of inclusion of stored suspended sediment.

215 Headwater tributary inputs – Are there geologic setting/landform/relief differences among the headwater tributaries that might affect the sediment inputs from hillslopes/ravines? For example does the WCC Tributary with the flux estimate have a similar wetland/forest proportion and steep vs. flat zones? It looks a little less steep in the E Branch compared to the West Branch and Broad Run. Please confirm that the landscape is homogeneous from north to south. This could be described more in the discussion (689-693).

~224 hillslope vs. river corridor source partitioning– Would eroding valley side slopes in confined valleys adjacent to channels have a fingerprint of hillslope or river corridor? By the definition used in this paper it would be hillslope? Management wise, would it be important to distinguish valley side slope failures adjacent to channels, caused by fluvial action, from landslides and soil creep on hillslopes? Maybe this is splitting hairs but since they are caused by different geomorphic and hydrologic processes would it be good to know where the valley side slopes are contributing? Please clarify the definition a bit more.

~264 Confined banks definition – Are you confident that all zones of confinement have low erodibility in the landscape? I'm more familiar with younger post-glacial systems where confined and partially confined/entrenched valleys are cut through unconsolidated deposits and the outside of meander bends can contribute ~1,000 Mg/yr because of their height. Just want to confirm that any steep side that is identified is hard or bedrock.

Figure S7 – missing "." at end of caption.

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Figure S8 – add decimal place on vertical axis

280 Mean bank erosion rates of ~10cm/yr--After looking through the methods in the supplementary information I still have questions if the rates on the outside of eroding meander bends in the Mccarthy, Allmendiger, and Pizzuto studies (table S4) are too high to include in a data set to represent both banks along all river lengths, even with the additions of stable locations? With this sort of lateral retreat rate along forested banks there would be trees leaning and falling and bare vertical eroding banks along about half of the cumulative unconfined lengths. Is this supportable by the field evidence? Do you have any observational evidence of sections that are widening or incising as well as laterally migrating? Are all the channels (of all sizes in the watershed) of the meandering type so that they have lateral migration as the geomorphic process? Please clarify and support the statement.

327 Erosion rate estimates and equation 5. As was mentioned in the text the erosion rate equation seems to underestimate the amount of erosion for erosion rates above about 25 cm/yr. Why do you think the equation underestimates the higher observed erosion rates? It would be good to add a sentence explaining this. Also maybe note in Figure S9 what is causing the large spread of predicted values, including the two overly high predicted rates of 25 cm/yr for observed rates of 10-15 cm/yr?

334 Bank height

Figure S11 – fix decimal places in vertical axis.

336 Particle size data for bank or sediment? – was all of eroded bank sediment assumed to be fine-grained silt/clay and able to be transported as suspended sediment with the potential to become overbank sediment? I think it was stated earlier that the banks were fine grained. Was there differences in texture that would affect the density more so than depth? How about differences in organic content?

338+ Floodplain sedimentation -- Nice use of previous alluvial chronologies to determine thickness and fraction of banks composed of legacy sediment and 10-yr flood inundation for area. Description was easy to follow. Did Happ et al. 1940 (https://www.researchgate.net/publication/249823681_Happ_SC_Ri;enhouse_G_and_Dobson_GC_1940_Some_principles_of_accelerated_stream_and_valley_sedimentation_US_Department_of_Agriculture_Technical_BulleFn_695) do valley fill studies in the Piedmont? Maybe add to the reference list.

Text S5.2 – add "()" for equation S5.

391 Routing sediment budgets – method is explained well.

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363 Calculation of 10-yr floods. Figure S14 is in English units, not sure if it should be converted to metric. Figure S15 is helpful – thank you for including it.

440-489 Uncertainty calcs – Great amount of detail and thought put into how to represent uncertainty for erosion and deposition. It would be helpful to put it in perspective in the last paragraph. Perhaps a statement on the resulting assumption of order(s) of magnitude confidence with the estimates.

> In supplemental text S6.1 for headwater input fluxes you may want to mention the uncertainty associated with spatial variability in landforms and sources of sediment across headwater tributaries. Other sources of error for bank erosion rates that might be good to mention is the assumption that all the eroded sediment is transported in suspension into the next reach.
>
> In Supplemental text S6.2, check font of text between equations S10 and S11.

Supplemental text S7 – The notation list was helpful. Thank you for including it.

501 Sediment budget floodplain deposition (fig. 2C)– Along the lower West Branch there looks to be a zone of higher deposition – can this be attributed to a flat/wide zone from local geologic structure? And its locality relative to a high headwater input (fig. 2A). It would be good to describe relative to what might be happening with the geology. Also, are confluences hotspots of deposition?

575/589 Sediment "yield" should be replaced with "flux", or "export"? Watch terminology consistent. "Yield" for hydrologists and land/water managers usually refers to a per drainage area basis, as Mg/yr/km^2.

633-636 I know this is discussion but I would tend to disagree with this statement. Legacy sediment as defined here is the "middle portion" of eroding banks, which likely have a higher bank height because of overbank sediment thus contributing more sediment to downstream areas if bank retreat rates are high. And contributing ~1/3 of the portion of watershed sediment flux seems substantial enough to be a concern to sediment management.

674 – Confined banks and sediment contributions – perhaps a closer look at surficial geologic maps would help to determine where the channels abut unconsolidated sediment/stratigraphy in valley sides. SSURGO soils data only extends to 5 m depth but sometimes the descriptions/categories of parent material and geology can be helpful.

680 – The choice of the 10-year flood seems justifiable to based on my experience to help define the area that could receive floodplain deposition.

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690 – It would have been helpful to have more of a description of the geologic variability that affected relief, planform, and erodibility in this watershed.

695 – Thank you for describing the difficulty in applying local data representing channel and floodplain changes to a spatially diverse watershed. There is also the episodic nature of bank erosion that is more representative of decadal rates, dependent on the timing of floods, compared to annual flux rates in suspended sediment at watershed outlets. Repeat lidar measurements, with repeat on the ground reach topographic surveys, and rapid geomorphic assessments for validation are helpful. More often than not it is the mapping of areas of eroding banks, and application to the stream network, rather than the lateral retreat rate (which can be estimated based on geomorphic observations), that is most important for spatial recognition of hotspots of erosion.

725 Legacy sediment comprise 45 +/- 14% -- this value seems different than the three possible given in the discussion. Please check and clarify. It seems like it would be better to give the 1/3 proportion to the outlet sediment flux here instead of referring back to previously published data.

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Recommendation by Associate Editor 2 (anonymous)

Completed: 2025-11-17 10:28 AM
Recommendation: Major revisions

For author and editor

Dear author(s) and editor,

After reading the manuscript and two anonymous reviews, I recommend Major Revisions. The manuscript addresses an urgent and timely method to assess the effectiveness of sediment management practices by looking at sediment budgets at a reach scale and how they correspond to the watershed scale. This will be a very useful paper for practitioners and decision makers and I look forward to a revised version that addresses the many different issues raised by the reviewers.

In addition to the reviewer comments, I encourage the authors to be consistent with some of the link in-text citations and references. At least one is missing the 'last accessed' statement. Please check APA and the Geomorphica guidelines to make sure the right format is used. Most importantly, be consistent.

Figure 1 - add an extra panel showing the location within the US and PA for readers unfamiliar with the area.
Figure 1 - check for color accessibility (this and all figures in the main text and the supplementary material). Results figures seem ok but still check them.

The color scheme might not be accessible to readers with color vision deficiency. I suggest uploading images to Coblis (https://www.color-blindness.com/coblis-color-blindness-simulator) and testing them to make sure the color schemes are appropriate for everyone. Accessible color maps are available through the work of Fabio Crameri (https://www.fabiocrameri.ch/colourmaps/). Their publication from 2020 is very useful (https://doi.org/10.1038/s41467-020-19160-7).

There seem to be missing words in a sentence. Lines 173-174
Line 195 - explain 'blue line' mapping.
Line 295 add symbol for bankfull depth as it was done for relief, R.
Some words or terms throughout the manuscript have quotation marks and I do not think they are necessary. For example, Line 204 "closing"; Line 243 "bank erosion". If the quotation marks are there to indicate some meaning, just describe it.

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Decision by Editor-in-Chief (Alice Lefebvre)

28 November 2025

Thank you for submitting your manuscript entitled "Nested, Spatially Distributed Annual River Channel Sediment Budgets Pinpoint Sediment Sources and Identify Downstream Sediment Transport Pathways" to Geomorphica. I have now received two reviews and an Associate Editor recommendation (included at the bottom and/or attached to this email). I have looked at the paper, the reviews and the Associate Editor recommendation myself.

On this basis, we would like you to undertake a major revision of your manuscript. As this is a major revision decision, after you revise your manuscript, it will be returned to one or both of the reviewers who have reviewed this paper.

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Authors' responses to review comments

11 December 2025

Summary of Revisions

Note: Suggested revisions are presented in normal text, *our responses appear in italics*.

Overview

We very much appreciate the thoughtful and helpful comments from the Associate Editor and two anonymous reviewers. Below we outline our responses to all the comments, and detail the changes we have made to the manuscript and Supplemental Materials.

Revisions suggested by the anonymous Associate Editor

1. I encourage the authors to be consistent with some of the link in-text citations and references. At least one is missing the 'last accessed' statement. Please check APA and the Geomorphica guidelines to make sure the right format is used. Most importantly, be consistent.

After consulting the APA referencing style guidelines for web sites, all the link in-text citations and references have been modified so they are consistent with the relevant APA styles.

2. Figure 1 - add an extra panel showing the location within the US and PA for readers unfamiliar with the area.

Done.

3. Figure 1 - check for color accessibility (this and all figures in the main text and the supplementary material). Results figures seem ok but still check them.
   The color scheme might not be accessible to readers with color vision deficiency. I suggest uploading images to Coblis (https://www.color-blindness.com/coblis-color-blindness-simulator) and testing them to make sure the color schemes are appropriate for everyone. Accessible color maps are available through the work of Fabio Crameri (https://www.fabiocrameri.ch/colourmaps/). Their publication from 2020 is very useful (https://doi.org/10.1038/s41467-020-19160-7).

Figure 1 was substantially revised to improve color accessibility. The other figures in the manuscript were tested on Coblis as suggested and they looked ok. The figures in the Supplement were also uploaded, and all

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of them also looked ok.

4. There seem to be missing words in a sentence. Lines 173-174.

An error was corrected in this sentence.

5. Line 195 - explain 'blue line' mapping.

The reference to "blue lines' has been removed from the manuscript.

6. Line 295 add symbol for bankfull depth as it was done for relief, R.

The symbol for bankfull depth has been added as requested.

7. Some words or terms throughout the manuscript have quotation marks and I do not think they are necessary. For example, Line 204 "closing"; Line 243 "bank erosion". If the quotation marks are there to indicate some meaning, just describe it.

The use of quotes in the text has been eliminated.

Revisions suggested by Reviewer 1

8. What is the current state of knowledge on sediment source(s) determination? And why is it relevant, especially within the study area?

In the 3rd paragraph of the introduction, the term "sediment source" has been replaced by the concept of "sediment contributions from specific watershed locations". The term "source" is often tied to upland erosion areas, while the focus of the manuscript is on the connection between any location where sediment is in transport to any downstream location of interest. A sentence has also been added to the last paragraph of the Introduction to explain that locating sources and defining their connection to locations downstream is a key element in restoring the Chesapeake Bay, hence the relevance of this topic "within the study area".

9. Lines 91 – 99…this looks more like methodology

These lines have been rewritten to emphasize the new approach of nesting reach-scale sediment budgets. This clarifies the new contribution of the manuscript.

10. Lines 85 – 87: The reason behind nested sediment budgets is not fully justified compared to other available choices.

This paragraph has been rewritten to highlight the strengths of the nested sediment budget approach and to also describe some weaknesses of other available methods.

11. Headwater streams, definition?

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A definition of headwater channels has been added at the end of the 2nd paragraph of section 3.1 Sediment Budget Framework

12. Why 2008 aerial imagery for channel banks upstream? Any validation for the 140 stream channels?

A sentence has been added to explain the selection of the 2008 imagery for the study. Also, the text has been clarified to indicate that 140 reaches were needed to represent the river network by a series of straight segments (reaches). This can be considered a justification or explanation for why 140 reaches were used. We are not sure how this choice can be "validated" further.

13. Lines 212 – 220: Williamson's (2013) approach, as reported by Pizzuto et al. (2014), represents an attempt to estimate suspended sediment fluxes across ungauged tributaries. Scaling the resulting flux (361 ± 77 Mg/yr) by drainage area provides a straightforward means of generalizing the findings to other tributaries. However, sediment rating curves are highly site-specific, and their transferability is limited given the strong influence of local land use, geology, and storm dynamics on sediment transport. The extrapolation of fluxes to ungauged tributaries using empirical stream length–area relationships introduce further uncertainty, yet the cumulative error associated with these steps is not fully quantified. While the method is transparent as a first-order regional estimate, its underlying assumptions may oversimplify spatial variability in sediment dynamics, and the results should be interpreted with appropriate caution.

A sentence has been added to section 3.2 acknowledging that these methods are simplistic and that errors may result. The reader is directed to the Discussion for a full assessment of the errors that may arise.

Concerns about spatial variability of headwater sediment sources not accounted for by our methods are also already discussed in section 5.3, where additional research on this topic is called for.

14. Lines 232 – 245: Karwan et al. (2018) and Rose and Karwan (2018a, 2018b) provide an important contribution by applying geochemical fingerprinting and mass balance to stormflow samples at the WCC Tributary above London Grove.

Some concerns:

- The relatively frequent recurrence interval of this threshold (0.93 months, or 29 days) underscores the role of regular storm events in mobilizing upland sources. However, the subsequent partitioning of annual flux using Williamson's (2013) rating curve as a purely binary discriminator raises methodological concerns such as, assigning 100% of sediment below the threshold to river corridor (bank erosion) sources and 100% above the threshold to upland sources oversimplifies sediment dynamics and neglects potential mixing under

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intermediate flow conditions.

- Sediment provenance is rarely dichotomous; contributions from both sources are likely to co-occur across a range of discharges, with proportions varying by season, antecedent conditions, and storm magnitude.
- While the binary approach provides a tractable means of integrating the fingerprinting results into flux estimates, it may misrepresent source contributions and underestimate uncertainty.

These are all good points. A sentence has been added to acknowledge these shortcomings, and again, the reader is directed to the Discussion (section 5.3), where additional cautionary comments regarding the binary approach to sediment source discrimination have been included.

15. Lines 284: Based on field observations…where?

The locations of field observations are provided in the next sentence, where the reader is directed to the Supplemental Materials, Table S11. No changes have been made in response to this comment.

16. Lines 393 – 400: I acknowledge the idea behind this method. However, the method's reliability depends strongly on the accuracy and temporal representativeness of the local sediment budgets. Storage and remobilization processes are highly dynamic, responding to flood magnitude, vegetation, and geomorphic adjustments; assuming fixed fractions may mask this variability. Moreover, while the approach can quantify long-term average contributions, it may not fully capture episodic sediment pulses or lag times associated with floodplain storage and re-entrainment. Despite these limitations, the framework is a rigorous and conceptually clear way to integrate source attribution with downstream connectivity, provided the uncertainties associated with local budget estimates are carefully constrained.

These are reasonable concerns that have been addressed in the revised discussion (particularly Section 5.1).

<u>Revisions suggested by Reviewer 2</u>

17. References were adequate, except it would be good to reference Reid and Dunne 2016 for an example of the breadth of sediment budget components.

Reid and Dunne (2016) is already included in the references (cited in the Introduction). The potential breadth of sediment budget components (and the possibility that some components have been neglected) is discussed in Section 5.2, paragraph 2.

18. Title: The Title is a little long and perhaps "river channel sediment budgets" doesn't adequately reflect the floodplain deposition portion of the budget. Maybe something like

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"Watershed pathways of suspended sediment relative to streambank and hillslope sources and floodplain storage".

This is a valid point – the title is pretty long. Trying to emphasize the specific components of the budgets created in this study, however, seems too detailed and awkward. The title has been shortened to "Nested, Reach-Scale Fluvial Sediment Budgets Quantify Watershed Sediment Transport Pathways".

19. Non-technical summary – Last sentence could use some less technical wording.

This sentence has been edited to remove technical terms "sediment sources" and "delivery locations", and now simply refers to "watershed-scale sediment transport patterns".

20. Methods – The methods are described well but the supplemental text, figures, and tables were needed to understand the details needed to gain confidence in their methods.

By design. Including all the methodological details would have created a very long, overly ponderous manuscript, but the details are nonetheless essential to document.

21. Sediment sources – It is not mentioned in this paper but there could be some reference to how sediment sources are considered in watershed water quality models used for land management and sediment reductions. (This is a suggestion). These models typically do not include bank erosion directly, or network/reach storage directly (ie. SWAT etc.) and overestimate upland soil erosion in order to balance the observed flux at the watershed outlet. The watershed water quality models and resulting Total Maximum Daily Load reductions drive land management and focus in on reducing soil erosion from agricultural/cleared land. Hopefully more publications like this showing the importance of gullying and bank erosion and eventually linked to upland hydrologic alterations that can lead to increased incision, widening, and lateral migration (increases in meander belt width) will be helpful for really zeroing in on where land management can make the biggest impact. Any additional discussion points you can raise about how much corridor erosion has been increased due to changes in hydrology would be helpful.

A sentence on this topic has been added to the Introduction.

22. 122 – Land use/land cover – It would be helpful to know the proportions of ag/forest/wetland in the watershed and if they are concentrated in one area more so than others depending on the geology and topography.

Land use proportions have been added to the text.

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23. 175-188 Sediment budget components – In addition to floodplain storage there are other areas of deposition with different time scales of transport -- there are “overbank” storage areas associated with ravines and gully systems and tributary fans, which generally accumulate sediment during episodic runoff events (Reid and Dunne, 2016, fig. 16.1 in Tools in Fluvial Geomorphology). [Reid and Dunne 2016 is out of order in the reference list.] Please clarify if you are including these other depositional features in your floodplain group, or that you haven’t accounted for those. Thank you for noting the lack of inclusion of stored suspended sediment.

Reid and Dunne (2016) has been moved to its correct place in the reference list. The text has been modified to indicate that the river corridor sediment budgets do not explicitly include upland storage (section 3.1), but that the upland sediment partitioning (while simplistic) implicitly accounts for sediment stored on upland landforms (i.e., toeslopes, alluvial fans, floodplains along low-order streams, etc.)(section 3.3).

24. 215 Headwater tributary inputs – Are there geologic setting/landform/relief differences among the headwater tributaries that might affect the sediment inputs from hillslopes/ravines? For example does the WCC Tributary with the flux estimate have a similar wetland/forest proportion and steep vs. flat zones? It looks a little less steep in the E Branch compared to the West Branch and Broad Run. Please confirm that the landscape is homogeneous from north to south. This could be described more in the discussion (689-693).

The discussion explicitly notes that variability in headwater tributaries is not well captured by our methods, and that further research into this topic is needed (section 5.3). We have also acknowledged that this is a significant source of error (unquantified) in our predictions (section 5.2).

25. ~224 hillslope vs. river corridor source partitioning– Would eroding valley side slopes in confined valleys adjacent to channels have a fingerprint of hillslope or river corridor? By the definition used in this paper it would be hillslope? Management wise, would it be important to distinguish valley side slope failures adjacent to channels, caused by fluvial action, from landslides and soil creep on hillslopes? Maybe this is splitting hairs but since they are caused by different geomorphic and hydrologic processes would it be good to know where the valley side slopes are contributing? Please clarify the definition a bit more.

The Discussion now calls for further research to better locate confined river banks and to better understand the extent to which they can erode and supply sediment. The Discussion also notes that the method for partitioning upland from river corridor headwater sediment supply is too simplistic, and further research in this area is also called for.

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26. ~264 Confined banks definition – Are you confident that all zones of confinement have low erodibility in the landscape? I'm more familiar with younger post-glacial systems where confined and partially confined/entrenched valleys are cut through unconsolidated deposits and the outside of meander bends can contribute ~1,000 Mg/yr because of their height. Just want to confirm that any steep side that is identified is hard or bedrock.

Additional references have been added to cite previous studies documenting that bedrock exposures in streambanks and valley sidewalls are associated with reduced or minimal (i.e., unmeasurable) erosion rates in the mid-Atlantic region. The discussion has also been modified to note that this observation does not mean that sediment supply from confined banks is 0.

27. Figure S7 – missing "." at end of caption.

Corrected.

28. Figure S8 – add decimal place on vertical axis.

Corrected.

29. 280 Mean bank erosion rates of ~10cm/yr. After looking through the methods in the supplementary information I still have questions if the rates on the outside of eroding meander bends in the McCarthy, Allmendinger, and Pizzuto studies (table S4) are too high to include in a data set to represent both banks along all river lengths, even with the additions of stable locations? With this sort of lateral retreat rate along forested banks there would be trees leaning and falling and bare vertical eroding banks along about half of the cumulative unconfined lengths. Is this supportable by the field evidence? Do you have any observational evidence of sections that are widening or incising as well as laterally migrating? Are all the channels (of all sizes in the watershed) of the meandering type so that they have lateral migration as the geomorphic process? Please clarify and support the statement.

Table S4 has been modified to include mean, median, and standard deviation of bank erosion rate and other data. The median bank erosion rate of 5 cm/yr is now quoted in the manuscript, which does not seem to be particularly large. Furthermore, the approach outlined in this section is supported by 18 published studies cited in the text, so there is abundant evidence (nearly all of it from field studies) already presented in the manuscript. We do not claim, of course, to be able to predict bank erosion rates without error, and this has been emphasized in the revised discussion.

30. 327 Erosion rate estimates and equation 5. As was mentioned in the text the erosion rate equation seems to underestimate the amount of erosion for erosion rates above about 25

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cm/yr. Why do you think the equation underestimates the higher observed erosion rates? It would be good to add a sentence explaining this. Also maybe note in Figure S9 what is causing the large spread of predicted values, including the two overly high predicted rates of 25 cm/yr for observed rates of 10-15 cm/yr?

The text now notes that this "resists explanation beyond noting that our approach may neglect some important variables." Given that we have aggregated results from several studies to develop Figure 5, we cannot explain why some of the predicted values are "off" without further analysis and likely, additional field work clearly beyond the scope of this study. These comments also apply to the second question asked by the reviewer, as well.

31. 334 Bank height. Figure S11 – fix decimal places in vertical axis.

Done as requested.

32. 336 Particle size data for bank or sediment? – was all of eroded bank sediment assumed to be fine-grained silt/clay and able to be transported as suspended sediment with the potential to become overbank sediment? I think it was stated earlier that the banks were fine-grained. Were there differences in texture that would affect the density more so than depth? How about differences in organic content?

A sentence has been added acknowledging that the approach assumes that the height of the banks consists of fine-grained suspendable sediment, and references are included that support this. Organic content is now described briefly in section 3.5.1. It is also argued that the low quoted standard deviation of bulk density supports the use of a constant value.

33. 338 Floodplain sedimentation -- Nice use of previous alluvial chronologies to determine thickness and fraction of banks composed of legacy sediment and 10-yr flood inundation for area. Description was easy to follow. Did Happ et al. 1940 do valley fill studies in the Piedmont? Maybe add to the reference list.

The suggestion is appreciated, but Happ et al. (1940)'s excellent work does not include studies of the mid-Atlantic Piedmont that should be cited here.

34. Text S5.2 – add "()" for equation S5.

Done, thank you.

35. 391 Routing sediment budgets – method is explained well.

Thank you, appreciated.

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36. 363 Calculation of 10-yr floods. Figure S14 is in English units, not sure if it should be converted to metric. Figure S15 is helpful – thank you for including it.

Figure S14 has been converted to metric units. Thanks for suggesting this.

37. 440-489 Uncertainty calcs – Great amount of detail and thought put into how to represent uncertainty for erosion and deposition. It would be helpful to put it in perspective in the last paragraph. Perhaps a statement on the resulting assumption of order(s) of magnitude confidence with the estimates.

It seems inappropriate to comment on the orders of magnitude of the errors in the methods section, before any error estimates have been presented. We feel that this should be covered in the Discussion, after the results and their error estimates are available for the reader to see and evaluate. This discussion is already present in section 5.2. No changes have been made.

38. In supplemental text S6.1 for headwater input fluxes you may want to mention the uncertainty associated with spatial variability in landforms and sources of sediment across headwater tributaries.

A sentence has been added to supplemental text S6.1 noting that local variability in headwater sediment sources has been neglected, and that this represents a significant and unquantified source of error.

39. Other sources of error for bank erosion rates that might be good to mention is the assumption that all the eroded sediment is transported in suspension into the next reach.

A sentence has been added to supplemental text S6.2 to acknowledge this.

40. In Supplemental text S6.2, check font of text between equations S10 and S11.

Corrected, thank you.

41. Supplemental text S7 – The notation list was helpful. Thank you for including it.

Glad it was useful.

42. 501 Sediment budget floodplain deposition (fig. 2C)– Along the lower West Branch there looks to be a zone of higher deposition – can this be attributed to a flat/wide zone from local geologic structure? And its locality relative to a high headwater input (fig. 2A). It would be good to describe relative to what might be happening with the geology. Also, are confluences hotspots of deposition?

A sentence has been added to explain the zone of higher deposition along the lower West Branch (unusually

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wide and straight valleys resulting from local geologic control).

We have chosen not to explore how geologic variability and confluences (network structure) might explain the local sediment budget data presented here. This would be interesting and worthwhile, but would require detailed statistical analysis and adding more data on the geology of the watershed, which we feel would unnecessarily lengthen the manuscript and detract from our primary message, which involves the utility of nesting reach-scale sediment budgets to determine sediment transport pathways.

43. 575/589 Sediment "yield" should be replaced with "flux", or "export"? Watch terminology consistent. "Yield" for hydrologists and land/water managers usually refers to a per drainage area basis, as Mg/yr/km^2.

Corrected. Thank you for the suggestion.

44. 633-636 I know this is discussion but I would tend to disagree with this statement. Legacy sediment as defined here is the "middle portion" of eroding banks, which likely have a higher bank height because of overbank sediment thus contributing more sediment to downstream areas if bank retreat rates are high. And contributing ~1/3 of the portion of watershed sediment flux seems substantial enough to be a concern to sediment management.

The clause suggesting that legacy sediments are not a primary concern has been removed.

45. 674 – Confined banks and sediment contributions – perhaps a closer look at surficial geologic maps would help to determine where the channels abut unconsolidated sediment/stratigraphy in valley sides. SSURGO soils data only extends to 5 m depth but sometimes the descriptions/categories of parent material and geology can be helpful.

A sentence has been added suggesting future studies incorporating surficial geologic mapping.

46. 680 – The choice of the 10-year flood seems justifiable based on my experience to help define the area that could receive floodplain deposition.

Appreciate agreement with our use of the 10-year flood.

47. 690 – It would have been helpful to have more of a description of the geologic variability that affected relief, planform, and erodibility in this watershed.

Variations in geology have been added to the list of locally varying controls that merit further study. As noted above in comment 42, a detailed analysis of geologic controls is beyond the scope of this manuscript.

48. 695 – Thank you for describing the difficulty in applying local data representing channel and floodplain changes to a spatially diverse watershed. There is also the episodic nature of

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bank erosion that is more representative of decadal rates, dependent on the timing of floods, compared to annual flux rates in suspended sediment at watershed outlets. Repeat lidar measurements, with repeat on the ground reach topographic surveys, and rapid geomorphic assessments for validation are helpful. More often than not it is the mapping of areas of eroding banks, and application to the stream network, rather than the lateral retreat rate (which can be estimated based on geomorphic observations), that is most important for spatial recognition of hotspots of erosion.

The text has been modified to refer to "observations" rather than to "direct measurements" to include the possibility of rapid geomorphic assessments (including the mapping of locations of eroding banks) and other observational tools. We have already noted that repeat lidar measurements do not have the resolution required to be useful for documenting bank erosion rates in our watershed, so we have not commented on this further.

49. 725 Legacy sediment comprise 45 +/- 14% -- this value seems different than the three possible given in the discussion. Please check and clarify. It seems like it would be better to give the 1/3 proportion to the outlet sediment flux here instead of referring back to previously published data.

These sentences have been rewritten to clarify difference between the proportion of total bank erosion that consists of legacy sediment (45%) and the contribution of legacy sediment to the total watershed sediment flux (the ~ 1/3 referred to above).

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Round 2 Review

Comments by reviewer 1 (anonymous)

Completed: 2026-01-24 07:45 AM
Recommendation: Minor revisions

For author and editor

The Corresponding Author,

The manuscript is interesting, and the underlying idea is commendable. I have a few minor comments for the authors' consideration:

Line 95: Please remove the highlight.

Line 172: Please address the repetition in this line.

Lines 195–196, together with Line 202 and the associated Figure, are somewhat confusing. The authors may wish to revise this section to better clarify their intent and guide the reader's understanding.

In addition, the methodology section is currently quite dense. Including a summary table outlining what was conducted in this study, what was obtained or derived from the literature, and the corresponding sources could significantly improve clarity and enhance reproducibility.

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Recommendation by Associate Editor 2 (anonymous)

Completed: 2026-02-21 07:38 PM
Recommendation: Accept

For author and editor

The authors have responded to all reviewer's comments in detail. The manuscript may be accepted. Two of the three issues raised by R1 may be fixed by the authors easily before reuploading files for production. I disagree with the reviewer regarding the lack of clarity of Lines 195-196, 202 and Figure 1. I understand what the authors describe therein. If the authors believe that more material from the methods section can be moved to the supplement, please do. The study requires detailed explanation of methods and they must appear somewhere. I do believe that making the main body shorter is helpful for readers.

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Decision by Editor-in-Chief (Alice Lefebvre)

25 February 2026

Thank you for submitting your manuscript entitled "Nested, Reach-Scale Fluvial Sediment Budgets Quantify Watershed Sediment Transport Pathways" (56) to Geomorphica. I have now received two reviews and an Associate Editor assessment (included at the bottom and/or attached to this email). I have looked at the paper, the reviews and the Associate Editor recommendation myself.

On this basis, I would like you to undertake a minor revision of your manuscript. I am aware that the reviewer and the associate editor both recommended accepting the manuscript, but they also recommended some small changes which I would like you to do before I can accept the paper. Once you have submitted a revised version, I will assess the revisions myself, and I am likely to accept the manuscript quickly.

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Authors' responses to review comments

10 March 2026

Summary of Revisions

Responses to suggestions are presented in italics.
Note: In addition to the changes described above, a few minor typos have also been corrected. These may be viewed in the "track changes" version of the manuscript. No changes have been made to the Supplement.

Associate Editor

1. Two of the three issues raised by R1 may be fixed by the authors easily before reuploading files for production.

Addressed below (see Reviewer #1 comments and responses).

2. I disagree with the reviewer regarding the lack of clarity of Lines 195-196, 202 and Figure 1. I understand what the authors describe therein.

See comments below – this section has been edited.

3. If the authors believe that more material from the methods section can be moved to the supplement, please do. The study requires detailed explanation of methods and they must appear somewhere. I do believe that making the main body shorter is helpful for readers.

Changes have not been made. See comments below.

Reviewer #1

1. Line 95: Please remove the highlight.

Done.

2. Line 172: Please address the repetition in this line.

The entire paragraph has been edited to eliminate repetition and to enhance clarify and brevity.

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3. **Lines 195–196**, together with **Line 202** and the associated **Figure**, are somewhat confusing. The authors may wish to revise this section to better clarify their intent and guide the reader's understanding.

This paragraph has been edited to improve clarity and understanding.

4. In addition, the methodology section is currently quite dense. Including a summary table outlining what was conducted in this study, what was obtained or derived from the literature, and the corresponding sources could significantly improve clarity and enhance reproducibility.

We recognize that the methods used in this study are involved, and that detailed descriptions make for difficult reading. This is the rationale for including the lengthy supplement. However, we feel that further shortening of the methods section would not allow readers to understand how results were obtained, which is important to adequately interpret the results of our study.

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Round 3 Review

Decision by Editor-in-Chief (Alice Lefebvre)

10 March 2026

Congratulations! I am pleased to inform you that your manuscript entitled "Nested, Reach-Scale Fluvial Sediment Budgets Quantify Watershed Sediment Transport Pathways" has been accepted for publication in Geomorphica.

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