

Interactive comment on “Warming increases carbon-nutrient fluxes from sediments in streams across land use” by S.-W. Duan and S. S. Kaushal

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General Comments

This research addresses an interesting and relevant scientific question, within the scope of BG, using novel ideas and data. Specifically, the authors ask, how does land use and climate change affect sediment flux carbon and nutrient fluxes in stream sediments? However, this manuscript requires a large amount of editing and additional information. This paper could be much stronger if the procedures, results, and conclusions were presented more clearly. The methods need more detail. I had many both minor and major questions as to why certain procedures were followed and how decisions were made in the specific comments below. Specifically, in the statistics, you need to be much clearer about how you are grouping your data. It was difficult to inter-

C4474

pret results due to this lack of clarity. Throughout the paper, a number of regressions are used, and the type of regression is chosen simply based on the best correlation co-efficient. The authors need to explain which potential regressions they compared as well as potential mechanisms that cause such different relationships. As it is, it feels that the statistics guides the ecology and that the regression-fitting is completely post-hoc without any hypotheses. In the results section overall, your headings tend imply that you are first considering just temperature effects and then land use effects. However, there is a good deal of mixing in each section. You should re-name the sub-sections to better focus what is reported in each one. You also need to do a better job at separating concentrations from fluxes. Switching between these two abruptly was confusing and made some of your results unclear. The first three paragraphs of the Discussion section should be introduction – or at least parts of it, explaining why this is an interesting question and the pathways through which warming can affect fluxes. As it is, you should start the discussion section with a restatement of your results and then explain them, rather than describing examples from the literature. This could also be accomplished by restructuring the discussion section. Finally, a major finding of this paper is the estimate of how climate change and land use scenarios could affect carbon and nutrient fluxes. However, these estimations are not mentioned until the last paragraph of the manuscript. The methods and results of these findings need to be included earlier in the paper, before mentioning them in the conclusion. On a similar note, no conclusions are made about the interaction of land use and climate change. Based on the abstract, the title, and the comparison across land uses throughout the paper, it seems that a major finding should be the broad differences in response to climate change by streams of different land use. This is touched on multiple times, but seems to be overlooked as a major result. Addressing the issues described below with Figure 9 and discussing those findings more clearly in the text would help to address this problem. This research is exciting, but the authors need to improve their presentation to make the findings clearer and more convincing.

Specific Comments

C4475

Title – should this be carbon and nutrient fluxes, rather than carbon-nutrient fluxes?

P11297: L15-17. At what interval was stream temperature recorded? It was unclear if the monthly samples also referred to temperature. Regardless, this should also be included in Figure 2's caption. Also, why was this site selected for temperature data, rather than other sites? Was temperature data available at other sites?

P11297: L17-19. Explain what you mean by, "the long term trend is not clear". Was there analysis done on this?

P11297: L21. Was this at baseflow? How long had it been since a storm?

P11297: L22-25. How were the sites for sediment collection selected? Did "randomly" mean using a random number generator? Over what study reach length did you use? Was this all over 100 meters of the primary sampling site, for example? Finally, how did you decide to collect from 5 versus 10 (or some number in between) sites? Also, were water samples taken upstream of sediment collection, and were they filtered, to control for suspended sediment?

P11298: L1-2. Why were these temperatures selected?

P11298: L4-6. Although this is a laboratory experiment, the differences between mixing water and sediment in a flask versus high flow events in a stream should be mentioned. Especially considering the large differences in storm flow between urban and forested streams.

P11298: L9-10. Why were the samples kept in the dark?

P11298: L1-10. You state that the flasks were left stationary for sediment to settle, but you also state that the incubations were kept swirling. . . You need to make this clearer and also describe why you did these things.

P11300 - 11301: L29 – L1. The sentence including, "As it was used as a case study for prediction" should be in the discussion section and explained further.

C4476

P11300: L14-16. Make clearer if you grouped all landuses together to test for temperature differences.

P11301: L1-10. This should be moved to the Sample Selection or its own sub-section in Methods, as it describes data collection and not analysis.

P11301: L1-2. Again, what was the resolution of the temperature data? If it was measured once a month, how did you decide what days and what times to measure data at? How did you correct for potential diurnal differences as you traveled between sites?

P11301: L4. Was this the length of the channel upstream of the sample site to the headwaters? Make this clearer, and describe what stream data you used.

P11301: L5. Why didn't you include the buried streams? I think you don't need to mention this, as most people don't consider those pipes to be streams. If you do include it, give justification for your decision.

P11301: L7-10. The description of sediment loading calculations: "the values of width and fluxes of each section of the Gwynns Fall were the averages of the beginning and the ending stations, while the average width of tributary 10 channels was assumed to be 2 / 3 of the value measured each tributary site" is very unclear. This needs to be re-written to be more understandable.

P11302: L1-5. If discussed, the humic-like fluorescence and protein-like fluorescence data should be shown in the supplementary materials at least.

P11302: L6-9. Again, the sentence, "Changes in DOC concentration, humic-like fluorescence, protein-like fluorescence and P / H ratio during the 35 °C incubation were 0.2–2.4, 1.0–3.0, 0.5–1.3 and 0.2–0.4 times that of their original values, respectively." Was very difficult to follow. Is this across all sites? Also, because this is all shown in Figure 3, this should be a description not a re-stating of data shown more clearly elsewhere.

C4477

P11303: L11-15. "the difference was significant if only rural and suburban sites (POBR, MCDN, GFGL and GFGB) were included together, where a positive temperature effect could be observed ($p < 0.05$; Fig. 7)." I asked this earlier, but did you group all landuses together to test for significant differences between temperature groups? Or did you group all times within a given temperature incubation together? This needs to be much clearer.

Perhaps more importantly, why did you group your data this way? The comparison of 4 urban sites to 1 forested, 1 ag, and 2 suburban sites that have been grouped together doesn't seem realistic to me. I think the regression relationships much more convincingly describe the relationships observed than an artificial grouping of urban / non-urban.

P11303: L23-25. What about at 15, 25 degrees C?

P11303: L25-27. Across all temperatures? If so, state this.

P11304: L1-8. You need to set up this end section better. Previously, this research focused entirely on how climate change and landuse could influence sediment fluxes. Here, you bring in additional variables that had not been previously discussed as potentially explanatory. You describe this mechanism later, but some foreshadowing here is needed.

P11306: L7-10. In the sentence, "We speculate that an initial decrease in nitrate followed by an increase in later stages of the incubations was likely attributed to denitrification and/or immobilization occurring at lower temperatures and nitrification at warmer temperatures well over 10°C (Fdz-Polanco et al., 1994)", does this imply that it takes that much time for the samples to reach the temperature of the incubation? This seems unlikely. Is there data to back this up? If I'm misunderstanding, then it would be good to make the mechanism you're suggesting clearer.

P11308: L11-17. You should also mention in the negating effect of much higher

C4478

stresses on bacteria and fungi in urban streams, for example pollutants, and how that fits into your findings.

P11308: L21. Was % ash weight correlated with % ISC? This relationship needs to be stated, to understand how this is an intermediate variable between landuse and different nutrient fluxes.

P11309: L3-4. Same comment as above, but for sediment size, porosity, and composition – are these related to land use?

P11310: L20-23. This is the first time this table and prediction is mentioned. This is a really interesting finding and is even stated in the abstract. You need to include the methods used to make these predictions and the results in the appropriate sections, rather than describing them in the final conclusion of the paper.

P11311: L23-24. You state that, "variability in extremes in water temperature are also important in urban streams", but you need to explain how, if it relates to your findings, and if this variability in extremes was observed in the Gwynns Falls.

P11318: Table 1. It would be helpful to state here if both landcover and impervious statistics were based 30-m resolution land cover data. Also, explain why the % of different land uses do not add up to 100% across the board. Finally, what does the row for runoff (m) refer to? This needs to be explained more clearly and referred to in the text.

P11322: Figure 1. In the map of the Chesapeake Bay area, there should be some labels to show the location – states, ocean, Baltimore City. Also, there appears to be writing near the highlighted Gwynns Falls watershed, but it's illegible. The location of the Pond Branch site is confusing – is it highlighted on the map of the Chesapeake Bay area? Is it actually located in relation the Gwynns Falls watershed as shown? This needs to be clearer. Finally, what resolution is this landcover data and what is its source? Also, what is the source of the stream channel locations?

C4479

P11329: Figure 8. Are these linear regressions for all relationships? This should be stated. Also, why are these linear after so many other relationships used polynomial and exponential regressions? For the SO₄ at 35 degrees C incubation, the linear regression seems to be strongly controlled by the two heavily urbanized / high % ash weight sites, while there's a large amount of clumping at lower ISC / % ash weight. This relationship should be examined further and described more clearly.

P11330: Figure 9. Include a key for release versus retention. Urban (%) should likely be %ISC, as that's the urban indicator you've used here. The "electron acceptors" at the bottom of the graphics seem to add confusion, rather than additional information. Similarly, the many descriptions of "mineralization", "nitrification > denitrification" are too much. I don't think those pathways are necessary in this graphic; they could be described in the caption or the text. Also, does this need to be 3-d? Couldn't it be 2-d, but with an additional y-axis to describe the flux? On a different note, if this is also meant to show the effects of high temperature at low urban development (which it probably should), perhaps this should be a surface or lattice? As it is, this figure doesn't represent well your concept.

Technical Corrections

P11295-11296: L25-60; L 1-3. The phrase "the interactive effects of land use and potential climate change" repeats here, in back to back sentences.

P11297: L3-5. The description: "The Gwynns Falls sites from Glyndon (GFGL), Gwynnbrook (GFGB), Villa Nova (GFVN) to Carroll Park (GFCP) traverse a rural/suburban to urban gradient (Fig. 1 and Table 1)" was a bit awkward and could be clearer. Changing the order of the phrases would fix this: "The Gwynns Falls sites traverse a rural/suburban to urban gradient from Glyndon (GFGL), Gwynnbrook (GFGB), Villa Nova (GFVN) to Carroll Park (GFCP) (Fig. 1 and Table 1)"

P11297: L6. Site MCDN's full name is not written out prior to abbreviation

C4480

P11297: L8. Refer to Villa Nova and Carroll Park by abbreviations.

P11297: L15-17. It's unnecessary to state, "that were described above and in Table 1."

P11298: L3-4. Was the stream water used from the same site as the sediment? I assume so, but it should be stated explicitly

P11298: L23-24. Is there a word missing at the end of the phrase, "with maximum of 5"?

P11300: L16. Use a colon rather than a dash here, to avoid any confusion that 4 degrees C was actually negative 4 degrees C.

P11300: L20. The word "with" is probably a typo.

P11300: L26. This should probably read, "...there is a clear warming response. ..."

P11301: L2. Don't state both "at all sites" and "at the 8 sites".

P11301: L11. This should be "Results"

P11301: L13-14. Be sure to consistently use "land use" or "land-use", here and elsewhere. Also, you don't need to see the stream water "used for incubations"; just saying stream water is clearer and less confusing.

P11301: L22-25. The sentence, "The % ash weight and $\delta^{15}\text{N}$ increased from 1.3 % and 0.63 ‰ at the forest site (POBR) to 3.8–6.7 % and 1.95–1.89 ‰ at the degraded urban sites DRKR and GFGR, respectively" was very difficult to follow, especially keeping track of which numbers referred to which site and which variable. This should be written more clearly. You could perhaps remove the % ash weight from this statement, as you describe it again in the next sentence.

P11301: L25-26. "The $\delta^{13}\text{C}$, on the other hand, displayed the opposite pattern, and a depleted value was observed at urban GFGR." Again, this is a bit unclear – is this a significant relationship? And if so, what are the R² and p-value? Or is this comparing

C4481

sites overall?

P11303: L10. Re-phrase “highest value”. Perhaps greatest increase or release?

P11303: L13. “positive” and “temperature” are misspelled.

P11303: L21. You have abbreviated ISC multiple times. Do it once, and then use ISC, or don’t abbreviate it.

P11305: L4. “Service” should be “serve”

P11305: L1. “release” should be “released”

P11306: L20-23. The sentence, “Because phosphate cannot act as an electron receptor (as nitrate and sulphate), there is no a decreased sink for released SRP under anoxic conditions.” Has a number of typos and is unclear.

P11309: L11. This should be, “we did not account for all of these variables”

P11311: L4-5. The statement, our results regarding warming effects on N fluxes show a larger variability than SRP if all land use type are included” needs to be re-worded to make sense – should this be “show a larger variability in SRP”?

P11318: Table 1. ISC is the abbreviation for “impervious surface cover”, not “impervious land cover”. It would be helpful to state here if both landcover and impervious statistics were based 30-m resolution land cover data.

P11320: Table 3. Include the abbreviation of temperature to t in the caption.

All figures. For all figures, do not repeat in the title of the figure something that is said elsewhere. For example, in Figure 2, you don’t need a title because the information is stated in the caption.

P1139324: Figure 2. For the y-axis, add degrees or the symbol for degrees Celsius.

P11325: Figure 3. For the middle y-axis, list the unit as Raman Unit and don’t describe it in the caption. Also, label the sites by the entire row rather than in each plot—this

C4482

was confusing. Do the same for Figure 5.

P11328: Figure 7. Capitalize “rural”

Supplementary materials. These should be combined to one graph, with the equations in an additional table.

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