

Interactive comment on “Soil carbon and nitrogen erosion in forested catchments: implications for erosion-induced terrestrial carbon sequestration” by E. Stacy et al.

Anonymous Referee #3

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General This paper deals with a highly interesting and relevant subject by looking at the processes involved during Carbon and Nitrogen erosion and transport from forested catchments under contrasting climatic conditions (snow versus rainfall dominated). The study compares river sediment samples with soils at different slope positions, which is an interesting approach to provide new insights in the fate of C and N during different transport phases. The data presented are especially interesting since, with some exceptions (e.g. Nadeu et al., 2014, 2015; Boix-Fayos et al., 2015), most previous work regarding the fate of organic carbon and nitrogen after erosion focused on agricultural land and relatively small homogeneous catchments. Although erosion rates in forested areas are typically lower than in cultivated land, organic carbon concentration in forest

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soils are much higher and of different composition, making them a potentially important factor in the overall carbon balance as affected by soil erosion.

Although the research approach and the data presented are highly interesting, the paper in its present form does not fully fulfill expectations, in large part because of a lack of structure and conciseness throughout the paper. The abstract, discussion and conclusions need strong improvement as they only partly represent the contents and main findings of the paper, they lack structure often making them difficult to understand.

The introduction is informative and provides a good representation of the state of the art, yet the main objectives should be better defined and written much more concise. Now the paper mentions repeatedly that the research quantified volume and composition of sediments, but lacks to clearly state its main objectives and how these contribute to better understand carbon dynamics during detachment, transport and deposition in forest ecosystems. Several hypotheses appear in the discussion section, which are not defined in the introduction.

Methodologically, the paper may be flawed, because the sediment trapping efficiency of the sampling boxes was not reported, while this may affect results very significantly leading to entirely different conclusions. This requires much better discussion and where possible quantification.

Regarding the results, the authors find a clearly different result for ER in the on average higher located Bull catchments when calculated for different transect positions, while for the Provenance catchments no such differences are found (Figure 6). This seems to be a result of the fact that the Bull catchment has lower slope gradients and more possibility for deposition within the catchment, especially at depositional position, where relatively high C concentrations are found, leading to a low ER as compared to sediments. In contrast, in the Provenance catchment, the relatively high slope gradients lead to less deposition of fine sediment with associated C and N on depositional sites, leading to little difference in ER for different transect positions. This aspect is not

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clearly reflected in the discussion as it is. Furthermore, it is mentioned that in dryer years ER are higher (above 1) than in wetter years, when ER below 1 are found. The paper does not seem to come with a clear conclusion of how this difference may be explained.

The fact that inter-annual variation in sediment volume is higher than variation in C and N concentration in sediments might be an indicator that erosion processes are not so different between years. On the other hand, we do see important inter-annual differences in ER (higher in dry than in wet years), which insinuates that different processes may be active under wet than under drier conditions. It would be interesting to see some more discussion on these apparently contrasting results.

Overall, the discussion needs important restructuring and can be much more concise by focusing on the papers principal results, leaving out additional comments on issues not included in the results section (e.g. the whole discussion on roads). Moreover, at various points discussion is included and conclusions are drawn without providing data to support these. Either the data must be provided (if existent) or otherwise the issue must be removed from discussion and conclusions.

Specific (P and L refer to page and line numbers)

It would be good to add some photographs of the catchments vegetation cover.

The statistical data analysis (section 2.4) as well as its results needs further elaboration explaining which relations were evaluated exactly and showing more results in a more concise manner.

Soils were sampled until 80cm depth, but results are only given for the upper 20 cm in Table 2. Why is that? What about results for greater depth?

P2492L16: check units for sediments should not be kg N ha⁻¹ but kg ha⁻¹.

P2494L3: please correct sentence.

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P2494L1-8: Moreover, different erosion processes and transport distances also affect the possible breakdown of soil aggregates during transport, affecting protection of C and N (e.g. Nadeu et al., 2011; Boix-Fayos et al., 2015).

P2495L4: remove 'erosion' from 'eroded C and N erosion'

P2495L5-11: what about different Carbon pools in forested versus agricultural settings, being more or less sensitive to oxidation?

P2495L22-25: please correctly phrase the research questions either as a question or as an objective.

P2496L20-22: you already mentioned that a few lines before.

P2496L25: please define KREW.

P2497L7: What about texture in the Cagwin series?

P2497L14: how much is less than 78%

P2497L21-...: all following is methodology and should not be under study site description.

P2498L4: Figure 1 shows 21 sampling points (not 18)?

P2498L15: how was slope calculated for these small depositional areas, less than 10m long, with a DEM resolution of 10m?

P2499L1-7: can you say anything about the trapping efficiency of these boxes (see Verstraeten and Poesen 2000)? How much sediment passed the box and what was their C and N composition?

P2500L23-24: so do we have a higher or a lower concentration of sand in sediments as compared to soils?

P2501L4: how was water yield defined and measured? This was not explained under methods. Besides, reference should be to figure 4 not figure 2.

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P2501: the whole analysis of relation between water yield and sediment yield is potentially interesting, but does not seem to be relevant for your study and overall objectives. Leaving it out may give you a clearer message.

P2501L24-25: you already mentioned that at the beginning of the paragraph right?

P2502: the whole paragraph 3.3 is difficult to follow and would benefit from better structuring of the text.

P2502L2: again: do we have a higher or a lower concentration of sand in sediments as compared to soils?

P2502L6-12: sorry, I can't follow this sentence. Please re-write and simplify.

P2503L24: You probably mean Figure 5 a and b?

P2503L26: Interesting result, but where can we see this (figure, Table..)?

P2504L10: what do you mean by 'interactions between the variables'?

P2504L26-29: Is this referring to Figure 6?

P2505L5-8: this is discussion, not a result.

P2504L28: what does this mean exactly: 'For N, differences between each sediment year and the soil were even more pronounced'?

P2505L17: I am not so convinced that climate comes out as an important factor. Your results do show that inter-annual differences in total annual precipitation is important, but no clear differences were found between higher and lower catchments, with more or less contribution from snow as compared to rainfall. So precipitation volume is important, no matter if it falls as rain or snow.

P2505L21: Where can we see the results of this analysis correlation analysis?

P2505L23: Which subset? Please provide some more information.

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P2505L25: I am not sure what you mean here by an 'extreme sediment yield response'. There is a good correlation between water yield and sediment yield, but sediment yield values in your catchments are surely not extreme.

P2506L1: better than what?

P2506L8: remove 'sediment'. In fact, the entire sentence is unclear (Results from WY 2005–2011 supported. .). Which hypothesis? Above you stated that the hypothesis was that catchment characteristics are more important. So what is your hypothesis? If you have one (or more) it would be good to include these in the introduction together with a better description of your objectives.

P2506L16-18: what exactly do you mean by this? The catchments have high surface roughness and high spatial variability in processes? How do you know that? Your study did not assess spatial variability within catchments right?

P2506L27: what are 'native surfaces'?

P2506L8: connectively = connectivity

P2506L5-10: what has the distance of the road to streams to do with the erosion rates on roads? The distance determines how well sediments originating from roads are connected to streams and to what extent their existence may be reflected in the catchment sediment yield, but it does not affect erosion on the road itself. In fact, the whole discussion here on the importance of roads, does not seem to be relevant for your study and is probably better removed.

P2507L17: you are referring here to mean annual sediment yield? It may be that this catchment shows highest sediment yield since it also is the smallest catchment. Area specific sediment yield tends to be higher for smaller catchments due to less possibility for deposition losses during transport.

P2507L25: 'core stones' = coarse stones? And, how would the presence of many stones cause high erosion rates? Usually, stone cover is associated with lower soil

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erosion rates (e.g. Poesen et al., 1994).

P2508L1: where can we see the results of this comparison between sediment yields?

P2508L20-23: preferential erosion refers to the fact that preferentially the finer soil fraction is eroded that is also associated with higher C and N concentrations.

P2508L8-15: do you have any information on sediment trapping efficiency of the boxes? That is quite crucial for the interpretation of your results.

P2510L1-2: please check grammar ('..or thinning due if these..').

P2510L3-4: what exactly do you mean to say here?

P2510L13: which data you found are you referring to?

P2510L12-17: sorry, can't follow your argumentation here. Especially for the lower catchment group, no differences in ER between different transect positions were found. This makes it impossible to identify the source of sediments.

P2510L27: indeed, finer particles may be transported further, but still in the Bull catchments, the ER compared to depositional sites is below 1, meaning that we have a lower C concentration in sediment than in soils there, so most C stays at the depositional site, and so either a relatively high fraction of source material originates from sources with low C contents, or there are important C losses by oxidation during transport and after deposition in the box.

P2511L11: I don't see how we can have preferential detachment or transport of coarser fractions? In fact, the whole sentence L10-15 does not make much sense. Please revise.

P2511L15: what is a sediment basin approach?

P2511L19: this suggests well known non linearity in the relation between discharge and sediment yield.-

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P2511L26-28: please revise this sentence; it does not seem to make much sense.

P2512L2: the basins characteristics?

P2512L16-18: I don't see how the following statement relates to your discussion on the importance of trapping efficiency: 'where the low C and N capture efficiency in the basins would be attributed to local deposition of particulate C and N within the catchment'.. Please explain or rephrase. Also, what follows (sorption...) does not connect to first part of the sentence.

P2512L22: can we see the data to support this statement?

P2513L1-5: Yes, but the sediment yield values for your catchment are very low, so also total C and N exported is low. What may be important is that C and N stability in sediments with higher concentrations is different from stability and burial efficiency of sediments with lower concentrations. See also previous studies (e.g. Wang et al., 2014; Van Hemelryck et al., 2011; VandenBygaart et al., 2015) for more details on stability after deposition.

P2513L9: this may be true, but you did not present results on different carbon fractions. If you have such data it would certainly be interesting to include them.

P2513L17: remove 'slopped'

P2514L2-4: on what information is this based? How do you know C replacement and C mineralization potential is high?

P2514L14: what are 'light carbonations materials' and where are the data to support this statement? We only saw data regarding total C and total N, but not regarding different C fractions.

P2514L18: If it's not addressed, leave it out.

P2514L21-25: while this is certainly true, it does not relate to any of your results. You did not discuss or provide data to highlight anything with respect to stability of C during

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transport or deposition.

P2515L8-10: this may be true, but by looking at annual data, rather than events, based on your data you cannot say anything about the expected impacts of changes in rainfall distribution or intensity.

P2515L11-12: as above, you did not evaluate the impacts of changes in land cover so you can't make conclusions about that either.

Table 2: what about the transect in B203 as indicated on Figure 2?

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