

Hydrol. Earth Syst. Sci. Discuss., referee comment RC2  
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## Comment on hess-2021-231

Anonymous Referee #2

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Referee comment on "A conceptual-model-based sediment connectivity assessment for patchy agricultural catchments" by Pedro V. G. Batista et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-231-RC2>, 2021

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### General comments

This paper provides a modelling approach to analyse the effect of linear features on sediment connectivity in a mesoscale catchment. The authors put a lot of work into adapting an existing model such that it is able to account for these effects. I appreciate this effort and I think that this work is important for improving the understanding of sediment connectivity in agricultural catchments. However, I have some major points of criticism which are the following ones:

- The authors state themselves that a comparison between their model results and the measured sediment loads in the river should be performed with utmost caution. However, in the results and in the discussion they still make strong conclusions based on exactly such a comparison. The authors should therefore reformulate the discussion such that it reflects this uncertainty better.
- The comparison between the model results for the different scenarios and the measured sediment loads does not make sense for me in the way it is done currently. In their current analysis, the authors ignored important factors influencing the sediment connectivity in the catchment: Firstly, as I understand it from the manuscript, they treated all grassland areas like arable land areas in the model. Since around a third of the catchment area is covered by grassland, this leads to a large overestimation of sediment loads. Secondly, the authors assumed a two-meter grass buffer strip around all agricultural plots. The authors state that they don't know the real width of buffer strips in the field and that they therefore use a value of two meters for testing the sensitivity of the model. Even though the sensitivity analysis showed that the buffer width had a large influence on the model results, the comparison between modelled and measured sediment loads is only done for the two-meter scenario. Also the conclusions are only drawn based on this scenario. Even though the authors state that the two-meter scenario is more realistic than the scenario without a buffer, this value contradicts the values reported by other studies (e.g. Alder, 2015; Remund, 2021) and the legal requirements. Although this point is addressed in the discussion, I am missing a proper justification why the measurements are only compared to the two-

meter scenario. Thirdly, in their "shortcut" scenario, the authors assume that all roads and farm tracks are drained with shortcuts. (At least, this is how I understand it from the manuscript.) I expect that a major part of the roads in the Baldegg catchment is actually not drained by shortcuts. Therefore, it makes sense to use the current "shortcut" scenario in a sensitivity analysis, but not as a realistic scenario. Compared to reality, the current "shortcut" scenario is expected overestimate the real sediment loads.

Consequently, even though the "shortcut" scenario is most similar to the measurements, this is possibly simply caused by a bias in the model input. Even though I agree that roads and shortcuts are in fact important for sediment transport, I think this cannot be concluded from the current analysis. To state that "roads behave as conduits for sediment transport in the catchment", as it is done in L474f, it is inevitable that the scenarios are revised such that they reflect the reality in the catchment better. (At least for the first point mentioned. Second and third point may also be discussed.)

- The authors state that the catchment is representative for the Swiss plateau. However, they do not further elaborate on this. Other studies, however, rather suggest that the catchment has a low shortcut connectivity compared to other catchments in the Swiss plateau (see comment to L98). The authors should improve on putting their analysis in the right context.

Several specific comments (see below) should be addressed to improve clarity and reproducibility of the study. Additionally, the manuscript should also receive some revisions regarding language and correct spelling.

### **Specific comments**

L36: Talking about a "continuous displacement of small amounts" is wrong here. The displacement varies strongly between events and years, as you also state below.

L47: Rephrase.

L56: You should also add the most recent publications here, e.g.:  
<https://doi.org/10.1016/j.catena.2021.105290>

L66: "assuming they are able to explicitly take connectivity into account": Difficult to understand. Please write this more clearly.

L73: with a size of few square kilometres

L79: You state above that one major issue of erosion models is the uncertainty of input data. Then you state that you used a high resolution dataset (2x2m DEM). However, for whole Switzerland, a 0.5x0.5m DEM is freely available in the same quality as the 2x2m DEM. You still used the 2x2m DEM. Why did you not use the higher resolution model?

L98: Here you state that the Baldegg catchment is *patchy* and *representative* for the Swiss Plateau. Below, you only elaborate on the patchiness, but not at all on the representativeness. Either elaborate on the representativeness below or use another word here. Schönenberger et al. investigated two catchments in proximity or even inside your catchment. Compared to the distribution in the Swiss plateau, these catchments however rather seem to have a low shortcut connectivity. This indicates in my opinion that also your catchment is rather on the lower side with respect to shortcut connectivity.

L103: In Figure 1c, you use the term "infrastructure", here you use the term settlements. It is unclear how these two terms differ and what the term infrastructure means. Please use consistent terms here. Additionally, how did you treat the areas of roads? Did you include them into the settlement area? Or are they included in the agricultural land/forest area?

L117: Are tile drainage only located in water accumulation zones? (What are water accumulation zones? Are they determined based on topographic index, slope?)

L120: How did you determine these slopes? Which elevation model? The maximal slopes are strongly depending on the model used. You are referring to Figure 1b. However, the slope is not visible in Figure 1b.

L122: "in this case formed by the retreat of the Reuss Glacier in the south to north direction (~18,000 years BP)" -> Not important. Consider removing.

L127: MeteoSwiss -> Please add reference.

L132: What is approximately? Provide the range of numbers of grab samples taken.

L133: What is "opportunistic sampling"?

L136: Why 2020? Above you write that you only sampled till 2019.

L144: What is  $k$ ? I guess the covariate ID. This should be written explicitly. Additionally, in contrast to Vigiak & Bende-Michl, you are only using the first five covariates, but not the long-term trend covariates (6 and 7). Why?

L149: First column of table: Remove the word "is". Also the word "water" is not really needed. Second column of the table: This is not the quadratic term of  $Q_i$ , but of  $x_{2,i}$ .

L156: You are addressing the variance in sediment concentrations extensively. However, you are not addressing the uncertainty in daily discharge at all. Why?

L165: Shortly explain why you only focused on water erosion.

L193: "usually implemented" -> Rephrase. (It is either implemented or not. Possibly, you could write something like that this version is often used.) Provide references where this version is used.

L199: R version?

L200: SAGA version?

L201: The code does not contain any information on the versions of the packages used. To make sure that the code can still be used in the future, you should at least provide information on the package versions used. Consider also using tools like packrat, checkpoint or docker. To make the code useful, you should also provide examples of input files.

L219: It remains unclear how you derived the land cover map. The reference is not shown in the reference list. Therefore, I don't understand if you used a vector dataset that you rasterized yourself or if you used a raster dataset provided by Swisstopo. What does the resolution "1:25:000" mean in the latter case? If you used vector datasets: How did you deal with point and line features, e.g. roads or hedges? Did you assume widths for roads and hedges?

L220: The statement that spatially distributed crop statistics are unavailable is wrong. There is a plot-resolution crop dataset from the canton of Lucerne available freely for the whole canton (and accordingly for the whole catchment) for the year 2019. Why was this

dataset not used? (CP and  $K_{TC}$  depend on the crop and you reported them to be the most sensitive model parameters.) Lavrieux et al. state that one third of the agricultural area consists of permanent grassland. Therefore, I expect this decision to have a large influence on your results, leading to an overestimation of erosion. You should address this point at least statistically for each of the five subcatchments analysed and for the full catchment. (e.g. look at the fractions of grassland and reduce the estimated amount of sediment load accordingly). Alternatively, you could also do a spatially explicit analysis.

L226: Why did you use the 2x2m resolution DEM? (see comment to L79) How did you process the DEM, e.g. sink filling?

L227: In the  $K_{TC}$  column, consider indicating the land use classes belonging to "high" and "low" (e.g. in brackets). This would make it much easier to read.

L230: Specify that this relates to the maximum CP factor.

L233f: You talk about forests and grass buffer strips in the land cover map. However, the reader is missing were you explain the derivation of forests and grass buffer strips. Consider stating that you are explaining this below.

L246: How much wider? Refer to the article in the corresponding legislation directly, instead of Alder et al..

L249: What were your assumptions on buffer strips along hedges? Did you also use a 2m buffer? Or a buffer corresponding to the legal requirements? How did you treat tree lines?

L250: As mentioned in the comment to L219, I don't really understand how you derived the road areas.

L252: What is "infrastructure"? Was this also derived from the land cover map?

L253: If roads act as sinks, why is this related to field drainages? From the text, I don't understand where you assume the sediments to be trapped. On the road? In the drainage system? In sludge collectors? The scenario seems to make sense for me, but you should specify your assumptions more clearly.

L256: Did you assume here that all roads are acting as shortcut? Or only a part of the roads?

L262f: How many directions?

L266-268: In my opinion, some (or probably all) of the additional packages (e.g. "doParallel", "foreach") are not worth mentioning here, as they are only used to speed up the calculation process, but not important for reproducibility of your work.

L278: What does RFA stand for?

L280: Version?

L299: Do I understand correctly that  $\text{Mg yr}^{-1}$  means tons per year? Probably write tons instead.

L299: For me, the differences between GS and NGS scenarios are not well visible in the plots. Consider making this better visible, e.g. by adding a moving average per category or something similar.

L317-L318: How did you quantify this for the whole catchment? Just by eye? If yes, you should provide the respective plots (e.g. in the appendix). Otherwise, can you provide a quantitative assessment?

L324: In Figures 6b, 6c, 6e, 6f, and 6g, arrows indicating the flow direction would help to understand the plot better.

L358: In my opinion, Table 3 would be understandable easier if you would write 25%, 50%, and 75% instead of Q1, Q2, Q3.

L366f: As I understand from L244ff, you say that you don't really know what the real widths of buffer strips are in the catchment. It therefore makes sense to me that you use a fixed width of 2m and use it for testing the model sensitivity by running two scenarios – one with and one without the buffer strip. However, in L366 you now state that the 2m scenario is more realistic than the "no buffer" scenario. I agree that a 2m scenario is probably the more realistic scenario along forests. However, I expect the effect of a grass

buffer along forests to be small as sediments are trapped by forests anyways. Along roads, I doubt that the 2m scenario is more realistic than the "no buffer" scenario, since the legal requirement is only 0.5m (as you write in L430). (However, I might be wrong with these doubts.) Since I expect the buffer width along roads to be much more important for your model results than the ones along forests, I think you should report both scenarios here, or give a clear explanation on why you think or why you can show that the 2m scenario is more realistic.

L379-382: In the "Ron" stream, the 95% prediction interval seems much narrower than in the other rivers (Figure 8). Therefore, the observed values are mostly outside of this interval and the out of bound percentage is much higher than for the other streams. Can you explain this?

L389: Consider using the same y axis limits for all plots. Like this, it is difficult to see the differences between the streams. At least the zero line should be visible in all plots.

L422: Which physiographical statistics did you analyse? Please provide details. I guess you did not analyse crop types (e.g. fraction of arable land (without grassland) on the total catchment area)? Could this also be a reason for the difference?

L443: Where do you show in your study that model resolution is important for your results? I don't think that you can conclude this from your study.

L444-445: In L285 you state "Hence, modelled hillslope yields and suspended loads are not fully commensurable, and we did not focus on a rejectionist framework for model testing." Here, you state that "soil redistribution rates and patterns are intrinsically linked to linear features". The strength of the latter statement does not really fit to the caution you demand in the first statement. Therefore, you should reformulate this sentence.

L472-475: I very much like this part. In contrast to the discussion, I feel that here the strength of statements fits together with what you did in your work and with the related uncertainties.

L478: the effects -> the potential effects

L484: Would you not rather recommend a proper validation of you model before upscaling it?

## Technical corrections

L11: "In particular": Seems to be the wrong transitional phrase. Please rewrite.

L13: "grass-buffer-strips": Is that the correct term/correct spelling? (Revise in whole manuscript.)

L31: increase -> increases

L44: infra-structure -> infrastructure

L75: weekly -> weakly

L89: Baldegg Lake -> Lake Baldegg (revise in whole manuscript; see for example <https://doi.org/10.1039/D0EM00317D>)

L97: of the canton of Lucerne. (revise in whole manuscript)

L111: field-blocks -> field blocks (Revise in whole manuscript.)

L114: Consider just writing  $\text{km}^{-1}$

L120: Elevation -> The elevation

L141: water discharge values -> discharges

L194: Make a reference from this. No URL directly in the text. Check if there's a permanent identifier/URL.

L221: Wrong table referenced.

L235-238: Difficult to read. Rephrase.

L292: This can be easily visualised -> This is shown

L257: Is it a hydrological or hydraulic shortcut?

L306: increased in -> by or to

L372: In Figure 7, you write "short-cut", while in the whole manuscript you wrote "shortcut". Please adapt.