

Earth Surf. Dynam. Discuss., referee comment RC2
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Comment on esurf-2021-49

Anonymous Referee #2

Referee comment on "Sediment export in marly badland catchments modulated by frost-cracking intensity, Draix-Bléone Critical Zone Observatory, SE France" by Coline Ariagno et al., Earth Surf. Dynam. Discuss., <https://doi.org/10.5194/esurf-2021-49-RC2>, 2021

Dear Editor, dear authors,

The paper "Sediment export in marly badlands catchments modulated by frost-cracking intensity, Draix-Bléone Critical Zone Observatory, SE France" presents a very valuable data set that will be of the interest of the ESurf readership. Its conclusions regarding frost-cracking models and potential alternative proxies are relevant for the community and a timely publication. It is overall well-written and I enjoyed reading it. However, I recommend to the Editor that the manuscript is returned to the authors for Minor Revisions before publication. The suggestions I make below are mostly towards improving the clarity of the aim, hypotheses, and writing in some parts, and including a few additional figures.

My main concern is that the aim and hypotheses of the study are not clear in the abstract and introduction, and hypotheses of this study are hard to untangle from the conclusions of previous studies. For example, in lines 11-14 of the abstract, it says "rainfall variability does not fully explain (...) sediment export (...) suggesting that sediment production may modulate (...) sediment export". My first thought was that at this stage of the abstract, why ruling out the influence of other potential processes such as sediment storage? Later, in lines 84-85, it is clear that sediment storage is not relevant due to the very small scale of the studied catchments. But because this is not mentioned in the abstract, as it is written now, it's quite puzzling to the reader to see only one hypothesis favoured.

The abstract sound like the aim is to explore what controls the sediment export anomalies, but the first paragraphs of the introduction show that you have already, before doing any research, a pretty good idea of what controls those anomalies from previous published research (e.g. "Rovera and Robert (...) noted the marls' sensitivity to frost weathering..." (line 50); then line 55 "(...) inferred that these catchments was mainly dependent on the number of freeze-thaw cycles occurring during the year" lines 55-61 "Bechet et al. (...) inferred a yearly cycle between transport-limited conditions in spring to supply-limited conditions in autumn"). After the first page of the introduction, I get the

impression that this is a very-well studied field site and I don't understand what the aim of this current study is. When in line 86 it says "we hypothesize that frost-weathering processes can modulate sediment yield by controlling regolith production on hillslopes", this sounds too similar to the conclusions of previous studies and I don't understand why this is a hypothesis that needs testing if it has already been shown to be true. The goals of the study (lines 90-93) also need a bit more differentiation from what's already known in the study area so that the relevance of this study can come across more clearly.

Likewise, if the aim of the paper is to explore the controlling factors on sediment production/export, when I read that the summer surface temperature show a variability of 40-50 degrees Celsius (lines 239-237), I was surprised that, considering the data set available, solar-induced thermal stresses and their effect on physical weathering have not been considered as another potential variable influencing catchment sediment export (e.g. see Missy Eppes' papers).

Testing the volumetric expansion and ice-segregation frost-cracking models in "temperate/humid climate and soft lithologies" (Lines 77-79) is perhaps the most novel aim of this manuscript, and one that seems to adjust better to its content. However, this does not come across clearly in the abstract and introduction. I suggest rephrasing to put more emphasis on this, and carefully rewriting the current aim and hypotheses to more clearly differentiate them from the conclusions of previous studies.

In section 2, a bit more context on the catchments geomorphology (range and mean hillslope angles?) and dynamics (are there any frequent small landslides? Are the streams ephemeral?) would also be useful.

In the methods, the timing of data set acquisition is a bit unclear, see my line-by-line comments below.

Figures 3 and 4 show monthly total rainfall, but figure 6 focuses on rainfall intensity. It would be useful to show for reference a box plot of the distribution of rainfall intensity across the months (e.g. do October and November have also higher rainfall intensity, or just higher total rainfall because it rains more days?). It would also be useful to see how panel B of Fig. 4 looks like when average monthly rainfall intensity is plotted rather than total monthly rainfall. This would also help better visualizing and following the discussion of section 5.2.

Finally, showing a direct correlation of time spent below 0 degrees and frost-cracking intensity would add value to the paper and convey one of its most important outcomes more easily.

LINE-BY-LINE COMMENTS:

Lines 9 and 11: when saying "long data records" and "long-term" please add in parenthesis an actual timescale bracket. Otherwise it's a bit vague and different people understand different things by "long-term".

Line 43: "very large quantity of sediment" – again, this sounds a bit vague and open to interpretation, add some order of magnitude or range in parentheses

Lines 42-44: to follow this sentences better and to provide more context, it would be useful for the reader to know what's the magnitude and frequency of these floods typically

Line 51: "distinct evolution between S-facing and N-facing slopes" – distinct how? In the time, the magnitude of the response,....?

Line 55: how many years of observations does this time-series contain?

Line 62: what other similar sites? Please provide a couple of examples or delete this part of the sentence

Line 87: what is meant by "high-resolution" – give some more specific indication of the resolution.

Line 89: what winter season and "following year"? Would be handy to know the exact year.

Line 109: is the mean elevation of one catchment 850 and for the other, 1250 (and if so, for which), or does the elevation of both catchments range from 850 to 1250 m of elevation? Please rephrase to make this clearer.

Line 114: and how much would the average erosion rate be if the whole catchment is considered? Most studies do not remove vegetated sectors when providing catchment-averaged erosion rate estimates.

Line 120: please clarify the measurement periods and years for each of these data sets. You say later on line 135 that soil temperature was recorded between 2005-2019, but the

recording periods of sediment yield and rainfall are unclear. It would actually be useful if these study periods are mentioned in the abstract or introduction as well, earlier in the paper.

Line 134: it is a bit unclear how many soil temperature sampling sites there were: was it four on each catchment (south-facing top, south-facing bottom, north-facing top, north-facing bottom?). In figure 1D, only 3 sites are marked as SF-top, SF-bot, and NF, so it's a bit confusing if for the NF, there were also top and bottom sites, and whether there was only one monitored hillslope per catchment, or one in each catchment (so 8 monitored sites in total?). Also, what is the elevation of this monitored hillslope with respect to the mean elevation of the catchment?

Line 139-141: You say earlier that soil temperature was monitored between August 2005-December 2019. But then here you say "we specifically analysed soil temperatures during the winter season, from October 18th to 31st" – I guess this means that data was recording throughout the year but for this study you only focus on the winter temperatures? Or does this mean that only winter temperatures were recorded? Please clarify.

Line 148-153: show this relationship of air and soil temperature in the supplement – it's hard to follow a description of data that is not shown anywhere.

Line 152: what proportion of the winter season is snow-free?

Line 158: what previous studies? Please cite them.

Line 162: is that really your aim? The whole study seems focused to explore only one controlling factor, not test for other potential controlling factors.

Lines 210-211: these years of measuring periods of precipitation and sediment export should have been mentioned on the methods.

Line 219: are there any general trends of increasing or decreasing precipitation or sediment export across the sampling years?

Lines 342-343: why focusing only on small or marly catchments? It would be good to add some context and mention other studies that have shown that frost-cracking is an important control or modulator in sediment production (e.g. Hales and Roering's works on

New Zealand, Delunel et al., 2010).

Lines 365-369: please include these figures in the supplementary info, it's hard to follow and blindly believe data that you can't see.

Line 413: the phrasing "later in the year"/ "an initial"/"followed by" is a bit confusing in the context of a hysteresis cycle. This would be clear if rephrasing to something like "from June to September", etc.

FIGURES:

In general, all figures are on the lower-resolution side; higher-resolution, vectorized versions would be better for publication.

Figure 1: Some text is hard to read well because it's too pixelated, small, or a too fine font. In panel A, almost all text except the key and scale bar numbers are impossible to read. The cardinals are also impossible to read in all panels, I suggest just substituting for a bigger, bolder arrow pointing North. In panel B, all text is too small to be read easily, but the river names particularly. Panel C would be easier to read if the letters were bolder, or a white box is placed in the background and text switched to black. The black text in panel D is hard to read as well, it needs to be bolder, or have some outline in white, or a white box behind it.

Figure 2: Does (A) have the same x-axis as B? If yes, please clarify in caption, if not, please add labels on axis.

Figure 3: How have outliers been identified? Please explain on methods.

Figure 8: Choose a different colour for the weighted regression line that is not the same as the data points and error bars.

Looking forward to see the revised version of the manuscript!