

Earth Surf. Dynam. Discuss., referee comment RC2  
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## **Comment on esurf-2021-19**

Anonymous Referee #2

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Referee comment on "Controls on the grain size distribution of landslides in Taiwan: the influence of drop height, scar depth and bedrock strength" by Odin Marc et al., Earth Surf. Dynam. Discuss., <https://doi.org/10.5194/esurf-2021-19-RC2>, 2021

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Dear Editor, dear authors,

This paper presents a very valuable data set of grain size distributions supplied by landslides, and a simple yet seemingly effective model for predicted median grain sizes. This work will certainly attract the ESurf readership and is very worthy of publication.

However, the paper still needs Minor Revisions before it is ready for publication. The main issue I find is that is poorly written: some parts are very unclear, paragraphs are very long, some key points are buried in between other information, and there are a lot of grammatical errors. This makes the paper tedious to follow, and it's a shame because the data and the results are very exciting. Additionally, a major weakness is that the authors make certain claims about their data without showing the evidence in graphs in the manuscript or the supplement. Table 1, presenting the "raw" data, also needs more information and clarity in order to make this work fully reproducible, and more likely to be cited in future compilations. Their claims on bedrock strength need to be a bit toned down given the lack of direct measurements and the large uncertainties in the published ones. Below, I list some of these issues in a page-by-page, line-by-line basis (in capitals, my suggestions for rewording).

Looking forward to see the revised version of the manuscript!

Page 1

Line 1: river --> riverS

Line 2: "models have been developed for the grain size..." à models have been developed for ESTIMATING the grain size...

Line 4: "until now relatively..." --> Until now, relatively...

Line 5: distributionS, in plural, and we compare THEM

Line 6: saying only "depth" is a bit unclear, as you could be referring to the scar/excavation depth, or the deposit depth, it would be better to make this explicitly clear

Line 8: "weaker from" --> weaker THAN

Line 9: the word "deposit" is mentioned 4 times in this sentence, please rephrase (i.e. the first one could be change to "landslides", you could also say downslope vs. apex sectors)

Line 10: it's a bit unclear what do you mean by "inside the landslides" – in pits, in incised sectors...? Also, "...inside the landslides that presented percentiles 3 to 10 times..." is not correct (it sounds as if you were selecting specifically landslides with those percentiles). Please change to "... inside the landslides (deposits?), which presented..."

Line 15: you do not have measurements of the original bedrock block size, so this sentence may sound a bit misleading. I suggested saying "estimated original bedrock block size" instead.

Line 16: D50 proportional TO the potential energy

Line 17: "much stronger rock avalanches" is not correct, you mean avalanches that occurred in much stronger bedrock (the avalanches themselves are not "stronger").

Line 18: for future modelING

Line 19: riverS, in plural. Also, "aiming" may be better than "trying"?

Page 2

Line 2: parameter in singular. "Issues" sounds too informal, I suggest you change it to "processes". HazardS in plural.

Line 5: "sedimentary structure" is an odd phrasing, why not say "stratigraphy"?

Line 7: add comma after recent studies. Weathering on the critical zone reduceS, in present tense, it's not only a processes that occurred in the past.

Line 10: "incompletely weathered" sounds odd (as if the expectation would be to be completely weathered), I suggest changing this to "only partially weathered".

Line 20: you should write either "a physical scaling" or "physical scalingS", "derive physical scaling" is not grammatically correct.

Line 27: how was the point-load strength of the bedrock measured? Also, state explicitly what H stands for (I assume it's drop height?)

Line 29: either add commas after the k2 and k1 values, or add a "being" (e.g. "k2=0.5, an empirical..." or "k2=0.5 being an empirical...").

Line 30: landslideS, in plural

Line 31: the deposit should increase, in present tense, not increaseD – you are describing a process that still occurs in present time.

Line 32: Start a new paragraph with the sentence "However, subsequent studies..."

Page 3

Line 7: their model and resultS

Line 10: change common to frequent?

Line 11: add comma after studies: "based on these studies, we..."

Lines 11-12: "intermediate size and depth landslides" sounds a bit odd, "landslides of intermediate size and depth" may be better.

Line 12: typo on D50

Line 13: "second, WE HYPOTEHSIZE that materials..."

Line 14: "due to a reduction WITH DEPTH of the fracture density..."

Line 17: riverS

Line 20: "...where REPORTS of river GSDs exist in the literature"

Line 27: "we DETAIL below", in present tense

Lines 27-28: you say "for each deposit" twice in a row – why not write "how we constrained landslide characteristics and measured GSDs for each deposit"?

Line 31: Specify in parenthesis their sizes and lengths range, and also which landslides do you consider "small" (e.g.  $< 0.1 \text{ km}^2$ ?)

Page 4

Line 1: both sideS. In this line you talk 13 landslides being on the same lithological unit, which then on line 11 you mention again and explain is the Lushan formation. I suggest re-structuring this paragraph to make sure the information is given to the readers in

coherent blocks and to avoid repetition.

Lines 3-4: the sentence before hints that you are going to explain the lithological unit of the other 4 landslides, but then you talk in this sentence about their geographic position, which for readers not familiar with Taiwan, provides no lithological information

Lines 1-27: this paragraph is way too long, consider dividing in 2 or 3.

Line 5: landslides

Line 8: years

Line 13: change "last" for "other" or "remaining"

Line 16: compared to the other UNITS, not landslides? Since you are talking about the bedrock lithology

Line 20: "shales are about equally represented than sandstone" → "both shales and sandstone are equally represented"

Lines 16-27: if I interpret this correctly, there are no available rock strength estimates for the Lushan formation (where most of your sampled landslides occurred), only for the Nanchuang. As the authors are surely aware, it is extremely tricky to convert point estimates of bedrock strength based on rock samples or Schmidt hammer measurements into meaningful, hillslope or outcrop-scale bedrock strength estimates, the uncertainties are often too large to provide meaningful information (that's why many other studies refrain from doing so). Even if these strength estimates were considered representative, there is a wide range of values within the same formation. Yet, towards the end of the paragraph, the authors say "... we expect the rest of the landslide from metasedimentary units to be stronger than around 100 MPa" (why? This sounds very unjustified at the moment), and finish the paragraph by providing quite specific point load strength values to each lithological unit. The limitations of these estimates should be explicitly stated, and the final estimates provided should be given as a wide range that truly reflects the very large uncertainties.

Line 19: I assume that these data comes from Lin et al. (2008)? This should be appropriately cited.

Line 2: why estimating the scar slope rather than the pre-failure slope from previous imagery, or the hillslope slope from neighbouring undisturbed areas?

Line 3: "... the upper, respectively lower, volume...". It is very unclear what is meant by this. Do you mean you calculate minimum and maximum volume estimates?

Line 4: for a few landslides you have field volume estimates (Table 1), so it would be useful to see how well do the V-A scaling and field estimates compare, at least in the supplementary material.

Line 7-9: I assume W in this equation means width, but you should tell the reader. Also, why if Google Earth imagery was good enough to map the landslides, it was not good enough to estimate scar areas? Was the contrast between scar and deposit not clear? Please explain the reader why the need for a scaling. It is also unclear if the landslides for which observed dimensions did not match the scaling were the only ones for which you had field dimension estimates or not. If they were the only landslides for which you had dimension observations, and hence you could use them to test if the scaling works or not, why do you decide to apply the scaling to the other landslides despite it not working for these ones? If you have dimension observations that match the scaling, then: (a) show the agreement in the supplementary material, and (b) explain why do you think the scaling fails for "a few landslides", and which ones. At the end of this sentence, Table 1 is quoted, but if I go to Table 1, I can't tell which landslides have measured vs. scaling-estimated areas.

Lines 10-15: it is not clear in Table 1 if to estimate the volume of each landslide, the V-A published relationship, or a fraction of a cone was used (are those the ones with "field volume" estimates? Then it should be made clear in this section).

Lines 16-20: you are continuing your analyses choosing a "best estimate" fore each landslide, but which one you are choosing is not clear in Table 1. Please add a field in the table to make this clear, or mark in bold the numbers you consider as best estimate.

Lines 23-24: this one sentence paragraph is a bit odd on its own, and it is also not clear to what correlations you mean (i.e. the ones in Figs. 4 and 5 only?), and what the method of "random bootstrapped subsamples of the considered samples" consists of and why do you think it is needed/suitable/desirable for your data analysis. Please clarify.

Line 26: either you say "using the grid-by-number sampling METHOD" or "using grid-by-

number sampling”

Line 29: it is unclear what advantage had using a Phi scale and binning the data in the field measurements already (which as far as I’m aware, it is more useful for finer grain sizes, and the authors’ measurements bin all grains finer than 2 mm anyway), please explain.

Page 6

Line 1: it would be useful to include how many grains have been sampled per deposit on Table 1, and to also mark there which landslides were segregated, and for which ones there are several measurements available (surface vs. sub-surface, toe vs. apex).

Page 7

Fig. 1: the background DEM or hillshade appears so dark that it is hard to see the topography – I suggest you adjust this so that it is easier to visualize

Line 5: “coarser, respectively finer” – not sure what is meant by this. Do you mean that Locat’s GSDs were 10 times coarser and Crosta’s GSDs 10 times finer than your ones? Please rephrase to make this clear.

Page 8

Fig. 2: any ideas of why LS-16 is poorly fitted by log-normal and Weibull distributions? Was there anything different about this landslide?

Page 9

Fig. 3: in the caption, please add, for clarity: “Three examples of heterogeneity in grain size distributions ON A SINGLE LANDSLIDE DEPOSIT” or “on the same landslide deposit”. Otherwise it’s confusing as it may be interpreted as you are talking about heterogeneity across different landslides.

Line 9: was there anything special or different about those 4 segregated landslide deposits?

Page 10

Lines 16-18: you should show figures/data supporting these claims, at least in the supplementary information.

Lines 22-24: this sentence is very unclear, it is very hard to follow the reasoning because it is very poorly written

Lines 27-28: I understand the logic behind the strength scaling, but this needs to be explained better. Also, as I mentioned in one of my comments above, I am a bit doubtful that the data you have on bedrock strength allows you to say that "strength is 3.3 times smaller" - please rephrase to acknowledge the uncertainty.

Fig. S4: I suggest that this figure is moved to the main manuscript; as this data shows important intrinsic correlations between landslide size/depth and drop height, which act in opposite directions in terms of their control on grain size. The correlations of D50 to other landslide metrics such as area, width, volume and depth should also be shown in the main manuscript, otherwise you are not showing the data supporting your claim of lines 30-31.

Line 30: when you presented the data, you mentioned the different formations, but now you talk about "metamorphosed units" - keep a consistent nomenclature throughout, it will make the paper easier to follow.

Lines 31-34: so if I understood correctly, you are arguing for a greater drop height, mechanical control on landslides GSDs vs. a more weathering/bedrock fracturing control. First, this needs to be written more clearly. Second, it would be interesting to see if drop height and landslide metrics correlate with hillslope length and slope; as that would allow making rough predictions of the GSDs that a hillslope may supply in the long-term even when no active landslides can be observed.

Page 11

Fig. 4: I find the colour scale very hard to see, perhaps because the points are too small. Consider making them bigger or using a colour scale with more contrast per increment. Also it would aid visualization if you join the red dots with their corresponding adjusted

values with an arrow or a dashed line.

Lines 2-7: all these claims need to be backed up by showing these graphs, at least in the supplementary material.

Line 13: typo on D50

Page 12

Line 5: "proposed and validated by Locat et al., (2006) for large rock avalanches" should go between commas.

Line 6: landslideS

Line 17: where does this  $\lambda=2$  come from? What does it mean?

Line 19: how do you infer and quantify weathering intensity?

Line 21: does this  $D_b=1900$  mm make sense based on observations of the study area (i.e. do you see fracturing patterns in the fresh bedrock of landslide scars, or are the biggest boulders in channels of these size)? Would be nice to add a comment on that.

Line 25: "...factor of two from THE PREDICTIONS OF Eq. (1)..."

Page 13

Lines 5-6: what are the letters in Eq. (2) that represent the length scale of weathering and the landslide thickness? Please list them explicitly as you do for  $D_b$ .

Lines 6-7: Indeed some of these studies show, or imply, that there is a positive correlation between your  $D_b$  and bedrock strength ( $\sigma_c$ ). If  $D_b$  is predicted by some function of  $\sigma_c$ , that would imply that landslides' D50 increases non-linearly with  $\sigma_c^2$ . I would emphasize

more this important, potentially non-linear control of bedrock strength on landslide grain size.

Page 14

Lines 16-17: mention that in cases of vertical segregation, incised gullies on the landslide deposit can be exploited.

Lines 25-27: this first sentence feels like it belongs in the Intro, or at least it should have also been mentioned there.

Page 15

Line 14: I suggest changing "complexify" for "add complexity", of much more common use

Page 16

Line 21: "... consistent with LANDSIDES REPORTED IN previous literature..."

Fig. 6: rather than showing these data by landslide number, it would be more useful to have landslide depth or drop height on the X axis (you can also add a small label of landslide number).