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Interactive comment on "Significance of substrate soil moisture content for rockfall hazard assessment" *by* Louise M. Vick et al.

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We thank Dr Stock for a well-balanced and considered manuscript review. His comments are clear and constructive and where possible all suggested changes to the text and figures have been made.

1. I found it easiest to understand the results as a function of location, so I recommend that the authors make clear in each instance which site the results are from and what soil conditions that site represents. As an example, the caption for Figure 6 should state that these results are from the experimental rockfalls at Mount Vernon, which occurred under wet soil conditions.

We have made these changes.

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2. The values that they adjust to account for wet conditions are reported in tables, but I found myself wanting more information on exactly how they derived the adjusted values.

The explanation of the modelling method, when obtaining parameters to better reflect wet soil conditions, has been altered to the following (page 6, lower half): RAMMS parameters were adjusted incrementally until modelled runout paths showed a similar spatial distribution to that of the experimental boulder runouts. For each iteration of the model, parameters were adjusted to more closely represent wet conditions: the parameter κ was decreased by 16% for loess colluvium and 54% for loess, to reflect the longer slip distance through the soil ($1/\kappa$ = impact length); the parameter β was decreased by 16% for loess colluvium and 33% for loess, to reflect the longer impact time ($1/\beta$ = impact time); the μ-values were lowered by 33% for both soil substrates to reflect the decreased friction applied to the boulder over the period of the impact; the drag coefficient was increased by 40% for both soils, to represent the general greater drag on the boulder due to decreased soil hardness. These adjustments to the parameters were considered suitable when the runout envelope of both the experimental rockfall and the modelled rockfall were closely aligned, rather than changing the parameters by a specific pre-determined value.

3. It might be useful if the authors discussed how other models using restitution coefficients to represent boulder impacts with the substrate could be modified to account for wet soil conditions; as is, the discussion is limited to the RAMMS model, which is only one of several rockfall runout models in use.

We have added the following lines to the discussion (page 9, lines 27-31): RAMMS is the only rockfall runout model currently available that represents boulder-substrate interaction as slippage, with parameterisation thereof. Other runout models may require a different approach to representing the change in soil conditions and its effect on the boulder runout, for example reduction of the tradition coefficient of restitution for wet soil conditions, to represent the increased damping effect the soil has on the boulder

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during impact.

4. Perhaps the impact scarring data would feel more connected if the authors incorporated more discussion as to the usefulness of these measurements.

We have changed the caption and test of Figure 3 to clarify which impact scar depth:length ratios represent which moisture condition. The text has been changed in the results section (page 8, lines 1-5) to: Although both data sets display similar maximum depth:length ratios, the distribution of the values within the Mt Vernon data set (wet conditions) generally show a higher depth:length ratio. Scars that show a greater depth:length ratio are a result of impact of boulders which achieve depth in a shorter space during slippage/contact with the ground (Figure 4a & b). The Rapaki Bay impact scars show a generally lower depth:length ratio, indicative of shallower slippage through the soil during contact with the ground. The discussion section has also been altered to more clearly link the impact scar dimensions to soil moisture conditions and model parametisation (page 9, lines 5-17). Dr Stock raises an interesting question: If soil conditions are not known at the time of a rockfall, could they be inferred from impact scar measurements, potentially offering a field-based method of soil characterization after the fact? We interpret this question to be out of interest, rather than a suggested edit, and although we do not address this in text, agree that it is something that could be proposed as a future working direction. We would also suggest that future impact scar work link both boulder size and impact angle to scar morphology, as these likely have a marked effect on the resultant scar size and shape.

5. The authors tend to use passive voice (e.g., “samples were tested”), which leads to some ambiguity as to whether the authors performed certain analyses or whether they are referencing previous work. For example, on page 5, lines 10-13, it is unclear whether the authors inferred the moisture content of the soil at Rapaki Bay, or if this was done by Carey et al. (2014). Use of active voice (e.g., “we tested samples”) can help to reduce ambiguity.

The use of passive voice has been altered where necessary to clarify which tests were conducted by the authors, and which test results are referenced from other published research.

6. Regarding the rockfall experiment at Mount Vernon, the authors state that 20 boulders were triggered and mapped, yet figure the caption for Figure 6 indicates 70 experimental rockfall boulders. Why the discrepancy?

We try to make it clear in the methods section- page 5 line 26- that the mapped boulder deposits at Mt Vernon include rockfall boulder fragments. The boulders generally fragmented on first impact, and tracking only one fragment would have been difficult. The test has been changed to: As most boulders fragmented on initial impact, all fragments were mapped as boulder deposits- therefore seventy deposited boulder locations were mapped, from the initial triggering of only 20 boulders.

7. Figure 4 caption: The impact scars in “C” are representative of dry soil conditions (correct?), and thus only show examples of the schematic in panel “A”. Are there similar photos of impact scars in the wet soil conditions at Mount Vernon? If so, it would be nice to show examples from both wet and dry conditions.

Unfortunately, photos of scars from Mt Vernon in wet conditions are not good enough for level of quality required for published manuscript.

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