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Interactive comment on "Soil surface roughness: comparing old and new measuring methods and application in a soil erosion model" *by* L. M. Thomsen et al.

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Author comments to referee #1 (R1), Anonymous Referee.

We would like to thank referee 1 (R1) for his/her comments. We highly appreciate the time and effort taken by the referee to critically review our manuscript. The comments have helped us to improve the scientific quality of the study. Please find below our response to all comments and questions.

R1: "-It is hard to estimate how the used methods fit to the single conditions on the measured plots, as you dont have Figures (pictures) for all of them (or a representative

sample for every kind of testplot)" Response: Figure 2 has been updated to include an image of each of the land use categories.

R1: "I think the computation of the surface roughness using a best fitting plane (only one for every plot, right?) can lead to a misinterpretation of the roughness. This could especially the case for the very dense point clouds from the TLS and Stereophotogrammetry! I'm not sure, but in one part of your paper you talk about detecting single soil aggregates. Using only one best fitting plane (and deriving the distances to this plane) will give you the roughness (e.g. test plot in Figure 2) of the macro topography of the plot, not the roughness triggered by the single stones or soil aggregates! It could be good to make clear which kind of roughness you mean." Response: Yes, we agree. This comment is related to comments by Referee 3 who also pointed out confusion regarding the type of roughness we are measuring and we hope it is more consistent and clear now. We have now included the measurement across the cultivation direction for the contact-methods, this means that for all measurements both random roughness (captured along cultivation direction) as well as oriented roughness (captured across cultivation direction) are included in the RR values. However, we believe that macro-topography of the plot, related to landscape shapes are not included in the measurements exactly because of the fitting plane, i.e. if there were a global elevation trend in the plot it would be filtered out by the fitting plane. Figure 1 exemplifies how plane fitting will remove the macro topography of the plot.

[insert figure 1 here] a. b. Figure 1. Cross-section of an imaginary plot. a. shows the measured cross-section, where a global trend (an inclination) is visible, while b. shows the same cross-section after a plane was fitted to the data and rectified to parallel the x-y plane.

R1. The measured point densities by using photogrammetry and TLS are very high. I think you describe a massive oversampling of your plots. As an example: Your TLS has a footprint of 4 mm, which means, that normally you will completly cover your testplot (1 sqm) by 62500 -> to many points in your TLS data set! Response: We would like

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to thank the reviewer for this comment on oversampling. Point densities above the sensor footprint will not increase the accuracy. On the other hand, will oversampling decrease the accuracy? And further if the point clouds would be converted to grids, the higher the number of points that will be used to estimate the single cell height values, the higher is the statistical confidence of that number. This has been added to the discussion.

R1: How did you scan the plots (scan angle to the test plot). A very acute angle can lead to problems as you have an increasing footprint in your measure x-axis. Response: For the laser scanner the scan angle was approximately 45 degrees, but within a distance of 5-6 meters, which should ensure that the foot print did not vary too much within the plot. For the stereophoto the point clouds were constructed from >= 2 opposing images having angles of approximately 40-45 degrees and for the Xtion the angle was 90 degrees, i.e. perpendicular to the plot, which should ensure least distortion. Also since the plot only extends one meter, the differences within laser beam footprints/ stereophoto distances is expected to be very small. This has been added to the Methodology section.

R1: “As you say the comparison of the single methods is very challenging. I absolutely agree with you, but I won’t agree with your assumption, that TLS is the most accurate measurement device in outdoor environments! This strongly depends on the scale. I am not sure if it is the fact for your study and your derived roughness value!” Response: Indeed, the assumption that TLS is most accurate is not proven and it might be wrong. The accuracy is difficult to test in the uncontrolled environment of the field measurements. TLS was the only device however with documented accuracy tests. In the methodology section we have reformulated the statement now. Since we needed a reference we opted for the TLS as this device is the only one with thorough accuracy tests in both indoor and outdoor environments.

R1: “-I think for the comparison of the methods (Photogrammetry, XtionPro and TLS) it would have been better to create similar point densities by thinning (e.g. using the open

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source software cloud compare)." Response: This is indeed an interesting idea and we would like to do this exercise in future work. However, for the present manuscript we think it is beyond the scope to change the comparison method.

R1: "Why didn' you compare the point clouds or DEMs of the three methods (TLS, Xtion and photogrammetry) by doing a cut and fill analysis? Doing so you can estimate the differences between these DEMs and where exactly the single methods have disadvantages to measure a correct surface (which is the base for the computation of the roughness)." Response: As above, we think this could be interesting to do, hopefully this can be included in future work.

For the comments included in the supplement , please find our response below: Comment 1. "How was the angle between the scanner and the scanned object? The scanning angle has a strong influence on the beam diameter". Response: Please see our response to this issue above.

Comment 2. "This assumes that your test plots are very homogeneous regarding surface roughness. If this is the case, then it is ok". Response: Yes, within one land use category the surfaces were very homogenous. The point clouds were also visually inspected after the filtering to check that the three times sigma rule was ok.

Comment 3. "For an estimation of the accuracy of your measurements I think it would have been helpful to make more than one measurement of the same testplot (e.g. TLS) and compare the results of these repeat measurements for every single method" . Response: Yes, we agree on this suggestion, and we hope we could materialize it in future work.

Comment 4. "Perhaps it is better to produce similar point density by thinning the very dense point clouds. You won't lose information, as your footprint measures an area of 4 mm. 2 Mio point per sqm means a massive oversampling of your test plot!". Response: Yes, we agree with the reviewer about the oversampling; please see our reply to this issue above. Thinning out could be interesting along with conversion of the point clouds

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to grids.

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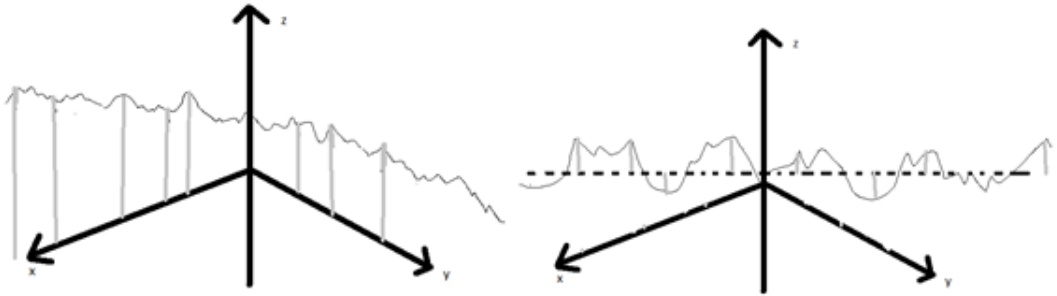

Fig. 1.

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