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Interactive comment on "Measuring bank retreat in fluvial environments with Terrestrial Laser Scanning (TLS)" *by* M. Foerst and N. Rüther

Anonymous Referee #2

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Foerst and Rüther presents a 2 years study of bank erosion in a snowmelt dominated meandering river using repeat TLS surveys. While better understanding the processes and controls on rates of bank erosion is critical, this study does not provide any new significant insight in this problem as it use a rather limited set of data (only 3 small discontinuous reaches) and lacks on several aspects in terms of methodological approach (in particular the treatment of uncertainties). The TLS method is interesting, but is no more new in itself. And the methods used to process the TLS data are rather standard (DEM of difference). Moreover, the writing is often unclear, and many important references are lacking (see the list suggested by reviewer 1. I've added 3 recent ones pertinent to the problem of bank erosion measurement with repeat TLS). Because the manuscript lacks on so many aspects, I suggest rejection as I cannot see how the paper can be saved without redoing all the post-processing of the point clouds, adding

more surveys or exploring really innovative approach in handling the point clouds and getting new scientific results on bank erosion.

Scientific Significance: The paper is really lacking on this aspect. Basically the reader learns nothing new in terms of processes or controls on the rates of bank erosion. And I doubt that with only 2 years of surveys and only 3 small discontinuous patches (how representative are they ?) which are not instrumented to measure other important aspects of bank erosion (water table, temperature...), much can be learned. There is nothing new in the processing of the TLS data, and it is even quite sub-standard compared to what has been done in previous work regarding the quantification of the error budget.

Scientific Quality: the post-processing of the TLS data is really sub-standard, and the lack of detailed analysis of uncertainties is detrimental to the analysis of the data, and the scientific inference that can be done from them. The authors need to come with a properly evaluated level of change detection in their context: can they detect 5 mm at 95 % confidence interval or 5 cm, or 20 cm ? This analysis should be done early on in the MS in order for the authors to evaluate if the differences of bank geometry are actually statistically significant or not. At present, we do not know if it's the case.

Presentation Quality: the writing progressively deteriorates towards the end of the MS and many sentences are hard to follow. It would need to be entirely rewritten by a native english speaker. The figures are not very informative and not really up to the quality of international journals. Reviewer #1 suggests cross-sections which could be indeed very helpful.

Detailed comments: The introduction lacks a very large amount of bibliography and reads as if the paper was submitted 5 years ago. The first reviewer has provided a very good list of references. I'll add on top of these the following two which deal specifically on methodological issues when comparing TLS data in the context of bank erosion (including the error budget and the change detection) : Lague et al. (2013), Barnhart

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et al. (2013).

P953L1 : confusion : LiDAR is not restricted to airborne lidar: a TLS is a ground-based Lidar

P953L7 : higher resolution is not the end of everything. You should explain why higher resolution is critical in the context of river bank erosion studies (depending on what you want to do, a simple dGPS survey of the top of the bank might be enough).

P953L19 : what do you mean by 'sensitive to changes in the water input' ?

P954L22 : it's TOPCON not Leica. Anyway, you need to provide the characteristics of this scanner (range, precision, accuracy, type of targets used, dual-axis compensator or not ...). You also need to give more info on the typical range at which you scanned and the resulting point cloud density. Here, you should also give more informations on how you register the various epochs with GPS (at present you give this info in the discussion). P955L26: you might want to check Brodu and Lague (2012) for advanced classification of point clouds in 3D (and in particular vegetation removal).

P956L1: you need to provide way more detail on the meshing and gridding procedure are there are various way to do that. Moreover, there is some confusion here: a mesh does not have a cell size, but a grid does. For the mesh generation, did you do a simple triangulation or an actual interpolation ?. And for the gridding, did you do a vertical projection (traditional way) or an horizontal one (as in some other papers on bank erosion or cliff erosion)? Moreover you need to discuss the uncertainty in your data (raw data and post-processing).

P957L1: it is not clear if you generate a DEM by projecting vertically the point cloud (which would results in a very large bias and discretization effects (see Lague et al. 2013 for a discussion)) or if you project your point cloud horizontally and then do a simple difference of DEM to measure a local bank retreat.

P957L3: why would you use the smallest value rather than the mean to define the

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distance between the two scans.

P957L8: how do you deal with the missing pixels in your volume calculation ? Why do you arbitrarily use 0.5 m as the maximum distance. It seems that in fig. 3 scan 04-05 the upper part of the bank has retreated by 0.5 m which worries me: it could actually be higher but your arbitrary criterion does not show it.

Fig 3: these planviews figure are really hard to read and not up to the standards of scientific publication of TLS data. Also in the absence of a discussion of the level of change detection you obtain with your instrument, setup and post-processing, there is little value in showing these results.

P958L4 : your results cannot be fully appreciated or discussed without a proper estimate of your level of change detection.

P960L16 : the previous section is hard to follow and lacks a real purpose. You need to make an effort to synthesize your results and focus on the key aspects.

P960L19: it is indeed not automatic if it needs to be adapted for each point cloud.

P961L1: see Brodu and Lague (2012) for advanced vegetation removal in 3D point clouds.

P961L4: you need to demonstrate that ! A bad point will locally decrease your capacity to detect a change and will increase your uncertainty. You need to quantify these aspects (see Lague et al., (2013) for an in-depth discussion)

P961L7: the geo-referencing error is not simply a translation, but might have a rotation component. if your instrument has a dual-axis compensator then you're right: the geo-referencing does not affect the slope measurement. But this is assuming that your manual post-processing is not actually introducing errors. Recall that any remaining outliers in your dataset would alter the topographic slope. By the way, except for a plane, a measure of slope on a topography will be scale dependent. So you need to define which scale you're using and try to come with an objective way to choose it.

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P961L25: confusion: the accuracy is not set by the footprint, it is a complex combination of the electronics, surface characteristics, atmosphere, measurement distance, angle of incidence.

P961L29: this starts to be extremely hard to follow and the discussion of the GPS is obscure. A proper evaluation of the total error budget should be done earlier in the MS in order to know which measurement is statistically significant or not. Moreover, the authors have to include a lot more bibliography on error budget than Schurch et al., 2011 in their analysis.

Bibliography: Barnhart, Theodore B., and Benjamin T. Crosby. "Comparing Two Methods of Surface Change Detection on an Evolving Thermokarst Using High-Temporal-Frequency Terrestrial Laser Scanning, Selawik River, Alaska."Remote Sensing 5.6 (2013): 2813-23937.

Brodu, N. and Lague, D., 3D Terrestrial LiDAR data classification of complex natural scenes using a multi-scale dimensionality criterion: applications in geomorphology, ISPRS journal of Photogrammmetry and Remote Sensing, 68, p. 121-134, 2012. doi: 10.1016/j.isprsjprs.2012.01.006

Lague, D., Brodu, N. and Leroux, J., Accurate 3D comparison of complex topography with terrestrial laser scanner: application to the Rangitikei canyon (N-Z), ISPRS journal of Photogrammmetry and Remote Sensing, 80, p. 10-26, 2013.

Interactive comment on Earth Surf. Dynam. Discuss., 1, 951, 2013.