Earth Surf. Dynam. Discuss., 2, C519–C524, 2014
www.earth-surf-dynam-discuss.net/2/C519/2014/

Interactive comment on "Impact of change in erosion rate and landscape steepness on hillslope and fluvial sediments grain size in the Feather River Basin (Sierra Nevada, California)" *by* M. Attal et al.

M. Attal

mikael.attal@ed.ac.uk

Received and published: 16 December 2014

We are very grateful to reviewer #1 for their very constructive comments and suggestions. We are still waiting for a second review but would like to give a preliminary response to the reviewer's comments. We respond to the general comments and then more specifically to the line comments.

Firstly, the reviewer notes that the difference in grain size between landslide material and soil is unsurprising: "it is obvious to the casual observer that landslides contribute

coarser material to rivers". We agree that this follows both conventional wisdom and the qualitative observations of anyone who ventures into the field. However, qualitative observations are not the same as quantitative data and we believe this is the first study that actually illustrates this point with actual grain size data for both soils and landslides in a similar parent rock in a given study area. The soil grain size data are probably the most novel, as highlighted by the reviewer. The reviewer would have liked more discussion about our observations in soils but we stress that a more detailed analysis of the soil properties, in particular their geochemistry, features in a companion paper (Yoo et al., Applied Geochemistry, 2011, referenced in the text).

We acknowledge that the analysis of fluvial sediment data is "messier". It would have been splendid if we had found a much clearer signal but Mother Nature had decided otherwise. The three basins along which we decided to analyse the downstream evolution of fluvial sediment grain size ended up exhibiting different behaviours, in particular Bean Creek which shows no clear transition from steepened to relict landscape. We tried to reconcile the observations in all basins within the framework of flow competence and discussed the potential cause for the different behaviour in each basin. The reviewer's main criticism is: "how do you untangle the potentially dominant effect of hillslope sediment supply on channel grain size distributions?" We acknowledge that this is difficult to assess and have therefore tried to be cautious in the paper. We say p.1066 line 8 "We therefore interpret the increase in sediment coarseness from the plateau to the steepened landscape as a result of an increase in both flow competence and the size of the sediment supplied from hillslopes to the channels". We believe that both factors are contributing to the downstream coarsening, for the following reasons:

(1) An increase in flow competence alone would not lead to the observed coarsening if sources were similar across the landscape. This is supported by the observation that there is a lack of coarse material on the plateau, as schematically illustrated in figure 12. For example, we found no clasts larger than cobble size at the plateau sites, whereas boulders were common at steepened landscape sites. This is a source effect.

(2) There is a statistically significant increase in grain size with flow competence in Adams Creek (Fig. 11). This dataset includes two plateau sites and four steepened landscape sites across a range of ω'm values (our variable expressing competence) spanning two orders of magnitude. This suggests that flow competence plays a role in the evolution of grain size along the studied rivers: the coarsest transported sediment tends to occur at the sites with highest flow competence, which is consistent with our understanding of sediment transport in rivers. The rest of the data is noisy but is not incompatible with a general increase in grain size with flow competence. Isolating the influence of flow competence from the influence of sediment sources on the trends observed is however not possible with the data at hand.

Line comments:

P1051 Line 9: This is a sharp break. I would rewrite the end of section 1 to emphasize what the goals of the study are and perhaps keep the study area description in section 2.

–> We will rephrase this part to make the narrative more fluid.

P 1059 Line 11: Perhaps describe the reach lengths in terms of # of channel widths?

–> We will add "which represents between five and 50 channel widths" after "100 m".

P 1062 Lines 3-5: I wanted to see a map of flow competence for the field area – perhaps add as another panel to figure 1? Also, why not just use specific stream power? It is easier to conceptualize (at least for me) and I suspect that changing the slope exponent from 1.15 to 1 will not fundamentally change the patterns/interpretations in figure 11.

–> Producing a map of flow competence would be challenging because it requires channel width measurements across the whole study area. Regarding the use of our competence variable ω'm rather than specific stream power: it is not clear in the literature that flow competence is related to specific stream power. Most studies relate competence to shear stress, but shear stress is difficult to quantify because of the co-

variance between hydraulic radius and slope. Instead, we used an approach based on unit discharge which has been validated in previous studies. As the reviewer says, changing the slope exponent from 1.15 to 1 would not have a significant impact on our results.

P 1063 Lines 18-22: This sentence is difficult to unpack. Not much is said elsewhere in the manuscript about the difference in hillslope flux for relict vs. adjusting slopes. Perhaps this deserves a whole paragraph here.

–> We will add text to clarify this point which is of importance when considering the response of the landscape to change in erosion rates (both grain size and flux do increase).

P1063 Line 26: I suspect there is minimal to no salt weathering occurring in the Feather River sites!

–> The reviewer is correct. But this is just a generic statement about the processes that can affect particles during their time in soils.

P 1064 Lines 14-15: Units missing. I think you mean 0.51 meters right?

–> Oops, the units are meters indeed, thank you.

P 1064 Lines 14-19: Interesting to note that nearly similar soil thickness despite 2-fold increase in predicted erosion rates. . .

–> Yes, this was one of the many surprises the study area had to offer. We speculate in Yoo et al. (2011) that this is due to the buffering effect of tree throw: in the study area, trees manage to grow even in the steepest part of the landscape, thus preventing soil thinning with increasing erosion rate.

P 1067 Lines 15-17: Isn't the rapid hillslope response simply reflected in the lack of inner gorges?

–> This is an interesting point. Indeed, in many places in the steepened landscape, hillslopes are tightly coupled to the channel with no clear inner gorge. This supports the idea that hillslopes are responding rapidly to the change in rate of river downcutting.

Figure 1: I would pair this with figure 3 as a two part overview figure, and eliminate the inset graphic currently with figure 3 (this is redundant since figure 4a serves much of the same purpose). As a general note, make sure that all labels and symbols can be read when printed out! I needed to zoom in significantly to see any details on many of the figures.

–> We thank the reviewer for this good suggestion, we will proceed as suggested. The figures have been designed for the portrait format which is the final format in esurf. It is unfortunate that the review version is in landscape format.

Figure 2: You could easily add the hillslope length and relief to this figure to help clarify the meaning of those variables (i.e., that Sh is a hillslope-averaged quantity rather than local. . .)

–> Thank you, we will do.

Figure 4: Enlarge Figure 4a, and perhaps color code the sample sites to make them visible. It's a little confusing to use circles for indicating the steepened channel reach, but it may work if the sample sites are color.

–> Thank you, we will do.

Figures 4b, 5, and 7 seem more like supplemental figures, but if they are included in the main text, perhaps combine them into one place?

–> We may move these figures to supplementary material, though we like to show the reader what the sites and samples look like. Combining them all in one figure would lead to a very large figure that may not fit in one page.

Figure 6: This figure is a little tricky to interpret since the relative position of the profiles within the basin is unclear. Aside from Bean Creek, which looks like it drains to the

NF Feather River, I suspect it would be easier to follow if you plotted all the tributary profiles alongside that of the MF Feather River.

–> We will follow this suggestion.

Figure 8b: This figure is confusing because of the discontinuity across measurement methods. Personally, I would remove it since all this info is readily available in figure 8a.

–> We have been thinking about the different ways of displaying this information. What we can see in 8b but not in 8a is the difference between samples in the coarse sand / gravel fraction, with the proportion of fragments in this fraction increasing with erosion rate. We will think about it.

Figure 9: Plots a) and b) are basically showing the same thing. I think it would be clearer to just show 9a and remove 9b.

–> We think it is important to display the information in 9b for future studies of sediment transport in rivers that will incorporate grain size and sources of sediment. In particular, the fraction coarser than 1 mm is likely to be bedload whereas the fraction finer than 1 mm has the potential to travel in suspension. Similarly, Marshall and Sklar (2012) refer to the potential bedload fraction as "rock-fragments" in their global analysis of soil grain size, although they use a cut-off size of 2 mm.

Interactive comment on Earth Surf. Dynam. Discuss., 2, 1047, 2014.