Referee comment to:

Journal: HESS

Title: Effect of hydraulic parameters on sediment transport capacity in overland flow over erodible beds.

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General comments:

This paper presents novel data on sediment transport in shallow overland flow derived from experiments in a 3 m long laboratory flume under eroding bed conditions. Such experiments are very important to better predict sediment transport capacity in process based erosion models. Different composite force predictors were tested to model sediment transport capacity for overland flow and a semi-empirical transport capacity equation was derived based on unit stream power. This paper is therefore well placed in HESS.

The results of the experiments are clearly described and evaluated. However, the paper should be overworked regarding the following comments:

1. It should be mentioned in the introduction that non cohesive sediments were used as bed material and it should be explained why sand was used.
2. The relation between surface roughness and the composite predictors used to quantify transport capacity should be discussed in more detail.
3. For validation of the proposed transport capacity equation a split sampling or jack-knife approach should be used.
4. In the conclusions it should be mentioned for what kind of soils the proposed transport capacity equation might be suitable.

More detailed comments are given below:

Specific comments:

- Page 6940, line 10: "…experiments were carried out using four well sorted sands…" Please add that the experiments were carried out in a 3 m long and 0.5 m wide flume.
- Page 6941, line 9-12: "…the detachment rate of flowing water is calculated as the difference between the sediment transport capacity and actual sediment load."
  $\rightarrow$ Please consider to mention, that the detachment rate also depends on the potential of rainfall and flow to detach particles and the resistance of the soil against detachment.
- Page 6941, line 14-17: "During the last three decades, several efforts have been made to analyze the influence of different hydraulic parameters on transport capacity…." Consider mentioning that this study focuses on approaches to quantify transport capacity in shallow overland flows. In contrast to river hydraulics, lesser research has been done to estimate transport capacity under the condition of eroding hillslopes.
- Page 6942, line 26- page 6943, line 4: Consider to re-arrange the order of the sentences in this paragraph:

"Hydraulic variables can be combined in different ways to form composite force predictors for the estimation of transport capacity i.e. shear stress, stream power, unit stream power, and effective stream power (Duboys, 1879; Bagnold, 1966; Yang, 1972; Govers, 1990). In consequence different composite force predictors were used to estimate transport capacity of overland flow…..But widely varying results were obtained….."
You may also consider relating the references given in line 27-29 on page 6942 to specific force predictors used by different scientists.

- Page 6943, line 29: Please mention that non-cohesive bed material was used in the experiments and explain why.
- Page 6944, line 28: Please add the total number of experiments and explain how the above given conditions were varied for the experimental runs. In addition, consider referring to table 1.
- Page 6946, line 22-23: "…R (m) is the hydraulic radius, which is considered equal to the flow depth (h) under overland flow conditions…"
  This assumption is only true when the flow width is much greater than flow depth.
- Page 6950, line 4-8: "…while for erodible beds the mean flow velocity is almost independent of slope effect because bed morphology and roughness is dependent on both discharge and slope…."
  Is this finding also true for the experiments presented here? Please relate your results presented in Figure 4 to the literature statement given in line 4-8.
- Page 6951, line 9-15: "The performance of shear stress was poor as compared to other composite predictors (Fig. 5a).The possible reason for its poor performance is that the shear stress required to attain a certain value of transport capacity for fine grains (i.e. 0.230mm) is significantly lower than that needed to attain the same transport capacity for coarse grains i.e. 1.022mm (Fig. 5a)".
  The given reason for the poor performance of shear stress is unclear, please explain in more detail.
- Page 6951, line 17-21: The influence of surface roughness on the composite predictors should be discussed in more detail. In general, transport capacity is expected to decrease with increasing surface roughness, since part of the momentum in overland flow is consumed by form roughness[1]. Increasing surface roughness leads to increasing values of total shear stress. Therefore total shear stress is a poor predictor for transport capacity. In contrast to shear stress, stream power is not affected by increasing surface roughness, while effective stream power and unit stream power decrease with increasing roughness. The latter finding might also explain the good performance of unit stream power and effective stream power.
- Page 6952, line 13-15 and Figure 6: In Figure 6 the transport capacity equation (equation 8) was validated using the same data set that was used to derive the parameters for equation 8. Please use a split sampling or jack-knife approach to validate equation 8.
- Page 6953, line 14-16: please explain the given statement in more detail.

[1] Gimenez and Govers (2002) report that form roughness may contribute to particle detachment in eroding rills, when the momentum of flow is big enough to move the roughness element itself

Technical corrections:

- Page 6945, line 5: “by taking the average” → “by averaging”
- Page 6945, equation 1: please add coefficient of determination
- Page 6950, line 23: please add the R^2 given in Figure 5c also in the text.
- Page 6951, line 9: please add the R^2 given in Figure 5a also in the text.
- Page 6952, line 8-11: Please mention, that it is easier to measure runoff and therefore flow velocity can be calculated using equation 7, which is therefore incorporated in equation 8.
- Page 6952, line 15: Please add the coefficient of determination.
- Page 6952, line 2: “In-addition” → “In addition”.
- Page 6953, line 12: delete “except shear stress”
- Page 6953, line 16: “soil mass” → “soil matrix”
- Page 6953, line 27-28: “physically based” → “process based”

Figures and Tables:

- Page 6960, Figure 1: Please add a scale bar or measures.
- Page 6942, Figure 2: Please add coefficients of determination to the trendlines displayed for the individual slopes
- Page 6943, Figure 3: Please add coefficients of determination to the trendlines displayed for the individual slopes