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Hydrology and Earth System Sciences Discussions

Interactive comment on "Effect of hydraulic parameters on sediment transport capacity in overland flow over erodible beds" *by* M. Ali et al.

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We would like to take this opportunity to gratefully acknowledge the anonymous reviewer 1 for his comments and suggestions to improve the manuscript. The reviewer provided many excellent comments and suggestions, and we appreciate the time and effort invested by the reviewer. We believe that the readability of the paper would be substantially improved after incorporating these comments. We replied to all comments individually.

General 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.

Response: We will mention in the introduction of the revised manuscript that non cohesive sands were used as a bed material for experimentation. It will also be explained that why non-cohesive sands were used and the revised text will be:

. . . Non-cohesive sands were selected, since they ignore the impact of aggregate stability on sediment transport capacity. Aggregates would have also a very variable size and density, introducing with this more parameters which cannot be recorded during the experiments. Moreover with these type of non-cohesive sands, sediment transport capacity can be achieved in such a small flume length i.e. 3.0 m (Gover, 1990; Everaert, 1991; Govers, 1992).

2. The relation between surface roughness and the composite predictors used to quantify transport capacity should be discussed in more detail.

Response: More details will be provided in the revised manuscript to explain the impact of the surface roughness on the relationship between sediment transport capacity and the composite predictors. The text will be revised as:

. . . It is generally known that the transport capacity decreases with increasing surface roughness and part of the momentum in overland flow is consumed by form roughness instead of transporting the sediment particles (Gimenez and Govers, 2002). Hence the total shear stress is a poor predictor for the quantification of transport capacity, which is also consistent with the literature results (Govers and Rauws, 1986; Govers, 1992). In contrast to shear stress, stream power is not affected by increasing surface roughness, while affective stream power and unit stream power decrease with increasing bed roughness (Gimenez and Govers, 2002). The latter finding might also explain the good performance of unit stream power and effective stream power.

3. For validation of the proposed transport capacity equation a split sampling or jackknife approach should be used.

Response: Jack-knife approach will be used for the validation of the proposed transport capacity equation.

4. In the conclusions it should be mentioned for what kind of soils the proposed transport capacity equation might be suitable.

Response: In the updated version of the conclusions, the limitations of the proposed equation will be mentioned: . . . Because the proposed equation was derived for the limited range of conditions i.e. 0.07<unit discharge<2.07 x 10-3 m2 s-1, 5.2<S<17.6 % and 0.233<D50<1.022 mm. So the care should be taken, when the proposed equation is applied beyond the conditions for which it was actually derived.

Specific comments:

1. 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.

Response: We will incorporate this in the revised manuscript.

2. 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." → 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.

Response: We will mention in the updated version of the manuscript that the detachment rate not only depends on the potential of thin layer of overland flow, but also depends on the potential of rainfall and the resistance of the soil.

3. 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.

Response: The proposed suggestion will be incorporated in the revised manuscript.

4. 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.

Response: The order of the aforementioned sentences will be re-arranged in the updated version of the text.

5. Page 6943, line 29: Please mention that non-cohesive bed material was used in the experiments and explain why.

Response: It will be mentioned in the revised version of the text that non-cohesive sands were used to conduct flume experiments. It will also be mentioned that non-cohesive sands were selected, because they ignore the aggregate impact on sediment transport capacity. Moreover with these type of non-cohesive sands, sediment transport capacity can be achieved in such a small flume length i.e. 3.0 m (Gover, 1990; Everaert, 1991; Govers, 1992).

6. 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.

Response: It will be added in the revised manuscript that a total of 81 experiments were carried out. Furthermore, the variation in flow conditions during experimental runs will also be explained and will be as follows:

. . . For each selected sand, different range of unit discharges were applied under four slope gradients i.e. 5.2, 8.7, 13.2 and 17.6%. Because the current experiments were carried out with 0.04 m thick layer of sand under erodible bed condition, thus the higher rate of unit discharges were used for coarse sand (i.e. 1.022 mm) as compared to fine sand i.e. 0.233 mm (Table 1). The summary of experimental data is presented in Table 1.

7. 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.

Response: In the light of above suggestion, this part of the text will be corrected and new text will be read as .....R (m) is the hydraulic radius, which is considered equal to the flow depth (h), because flow width is much greater than flow depth under overland flow conditions.

8. 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.

Response: Many scientists found that mean flow velocity is independent of slope effect (Govers 1992; Nearing et al., 1997; Takken et al., 1998; Nearing et al., 1999; Gimenez and Govers, 2001). This finding is also true for the dataset, which is used in the current study, because authors also found the same in one of their previous study for the same dataset (Ali et al., 2011).

9. 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. 0.230 mm) is significantly lower than that needed to attain the same transport capacity for coarse grains i.e. 1.022 mm (Fig. 5a)". The given reason for the poor

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performance of shear stress is unclear, please explain in more detail.

Response: In order to make the reason more clear, the text will be modified and will become . . .. The possible reason for its poor performance is that lower value of shear stress is needed for fine sand (i.e. 0.230 mm) as compared to coarse sand i.e. 1.022 mm to attain a certain value of transport capacity (Fig. 5a).

10. 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 roughness1. 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.

Response: As suggested by the reviewer, the respective part of the text will be modified.

11. 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.

Response: Jack-knife approach will be used for the validation of the proposed transport capacity equation.

12. Page 6953, line 14-16: please explain the given statement in more detail.

Response: As suggested by the reviewer regarding the impact of surface roughness on the relationship between transport capacity and shear stress. This part of the text will be revisited and the reason of the weaker relationship between transport capacity and

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shear stress will be modified and will become . . .. since part of momentum in overland flow is consumed by form roughness to detach sediment particles from soil matrix.

Technical corrections:

1. Page 6945, line 5: “by taking the average” → “by averaging”

Response: We will correct this in the revised manuscript.

2. Page 6945, equation 1: please add coefficient of determination.

Response: The coefficient of determination will be added in the revised manuscript.

3. Page 6950, line 23: please add the R^2 given in Figure 5c also in the text.

Response: We will add the R^2 in the text as given in Figure 5c.

4. Page 6951, line 9: please add the R^2 given in Figure 5a also in the text.

Response: We will also add the R^2 in the text as given in Figure 5a.

5. 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.

Response: We will revised the text as suggested by the reviewer.

6. Page 6952, line 15: Please add the coefficient of determination.

Response: We will add the coefficient of determination.

7. Page 6952, line 2: “In-addition” → “In addition”.

Response: We will correct this.

8. Page 6953, line 12: delete “except shear stress”

Response: We will delete this.

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9. Page 6953, line 16: “soil mass” → “soil matrix”

Response: We will change this.

10. Page 6953, line 27-28: “physically based” → “process based”

Response: We will modify this.

Figures and Tables:

1. Page 6960, Figure 1: Please add a scale bar or measures.

Response: The length of the flume (i.e. 6.0 m) is displayed in figure 1.

2. Page 6942, Figure 2: Please add coefficients of determination to the trendlines displayed for the individual slopes.

Response: We will add the R^2 values in Figure 2 to the trendlines displayed for the individual slopes.

3. Page 6943, Figure 3: Please add coefficients of determination to the trendlines displayed for the individual slopes.

Response: We will add the R^2 values in Figure 3 to the trendlines displayed for the individual slope.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 6939, 2011.