Hydrol. Earth Syst. Sci. Discuss., 8, C4715–C4719, 2011
www.hydrol-earth-syst-sci-discuss.net/8/C4715/2011/

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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Received and published: 27 October 2011

We would like to thank the reviewer No. 2 for his constructive comments that helped us improving the paper. We appreciate his critical reading and valuable comments. The following lines explain how we will address his suggestions/comments in the revised manuscript.

1. Regarding to the introduction, I think that writing a good state of the art is basic for a paper of this kind but it seems that the present word should go further than listing which publications refer to a similar topic. Please, consider extending the introduction explaining why the variables to have chosen to study are really important (and they are).

Response: The suggestion to provide more in detail information about the impact of different hydraulic variables (i.e. unit discharge, slope gradient, and mean flow velocity) on sediment transport capacity is an interesting one. For this, the relevant literature has been revisited and related information was extracted and will be given in the updated version as:

. . . Unit discharge, slope gradient, and mean flow velocity were mostly considered for the quantification of sediment transport capacity under overland flow conditions, because they can be easily measured in the field. Moreover, these variables also have pronounced impact on transport capacity. It is generally known that transport capacity increases with the increase of unit discharge, slope gradient, and mean flow velocity, since the energy exerted by a certain discharge on the bed increases with these variables (Beasley and Huggins, 1982; Govers, 1990; Everaert, 1991; Govers, 1992; Zhang et al., 2009; 2010a).

2. Regarding to material and methods, you talk about non-cohesive sediments but, what do you consider as non-cohesive? More explanation is required for that issue. Besides that, you do the experiments with sand of 4 different sizes but, why sand? Why these sizes? As previously commented, a more detailed explanation is necessary. On the other hand, is completely necessary to evaluate the sediment budget of a flume by using a laser scan? I think that taking samples is more than enough to make a simple estimation of erosion and deposition in a 3-m flume, moreover if the objective of that budget is just to evaluate if flume length is adequate.

Response: In the revised manuscript, more information will be provided about the selection of non cohesive sands. To answer the questions that why non cohesive and this sizes of sands were selected to conduct flume experiments?

. . . 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

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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). Flume experiments were carried out using medium to coarse sands, because majority of the existing transport capacity equations were derived either for fine materials ranging from clay to fine sands (Govers and Rauws, 1986; Govers, 1990; Everaert, 1991; Govers, 1992) or for non-erodible beds (Guy et al., 1990: Abrahams and Li, 1998; Abrahams et al., 2001; Zhang et al., 2009). In the past, Govers (1990) and Everaert (1991) had assumed that a flume length of 3.0 m is appropriate to reach the sediment transport capacity. According to the knowledge of authors, no one in the literature verified this assumption with experimental results. Therefore in this study, surface of flume bed was scanned with a laser scanner in order to verify this hypothesis that 3.0 m flume length is sufficient to reach the transport capacity. Whereas, it is not possible to confirm this hypothesis with the sediment samples that were taken during experimental runs.

3. The experiments and the results and described in a detailed way but, as in the case of the introduction, the discussion is just based in comparison of your results with the obtained by other similar studies done by the authors or people from their institutions; I guess that discussion should be deeper than a summary of results. Please rework that part of the paper.

Response: Keeping in view of this suggestion, the discussion will be extended in the results and discussion section, especially where the impact of surface roughness on the relationship between transport capacity and composite predictors is given.

. . . 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 (Govers 1992; Nearing et al., 1997; Takken et al., 1998; Nearing et al., 1999; Gimenez and Govers, 2001). The impact of slope gradient on mean flow velocity was also found non-significant for the flow conditions that were used to conduct the current erodible bed flume experiments (Ali et al., 2011).

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. . . The performance of shear stress was poor ($R2=0.61$) as compared to other composite predictors (Fig. 5a). 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).

. . . 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 (Gimenez and Govers, 2002). Increasing surface roughness leads to increasing values of total shear stress. Therefore total shear stress is a poor predictor for 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 effective 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.

4. Finally, you develop a general empirical equation of transport capacity from the results obtained by your experiments but, before publishing it I think that it has to be validated in other conditions; you are just working with one kind of sediment (sand), of 4 concrete sizes (not the whole distribution), with determinate slopes and discharges (quite low by the way). You should validate this equation for other kind of sediments or, in case you do not do that, you have to specify in which conditions (sediment, discharge-range, slope-range, etc) the equation can be used.

Response: Up to the knowledge of authors, the majority of the available datasets in the literature were collected for non-erodible bed conditions (Aziz and Scott, 1989; Guy et al., 1990: Abrahams and Li, 1998; Abrahams et al., 2001; Zhang et al., 2009). Whereas, the datasets are not given in the literature for those studies which are based on the results of erodible bed experiments (Govers and Rauws, 1986; Govers, 1990; Everaert, 1991; Govers, 1992). It is generally known that the momentum of the applied

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flow is preferentially consumed to transport the sediment particles instead of detaching the sediment from soil matrix under non-erodible beds (Gimenez and Govers, 2001; 2002). So the datasets collected from non-erodible beds cannot be used for the validation of an equation which is actually derived for erodible beds like the equation proposed in this study. Because under erodible beds, the substantial part of the available flow energy is consumed to detach the soil particles from soil matrix, while remaining is used for sediment transport.

In view of this discrepancy, Jack knife approach will be adopted for the validation of the proposed equation in the revised version of the manuscript. The bias and the standard errors associated with predictions of the best performing composite force predictor was assessed by using Jack-knife technique. In this technique, one observation is held out and the remaining observations are used to fit the coefficients. Then, the fitted model is used to make the prediction for the held out observation.

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