**Hydrology and
Earth System
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Discussions**

Interactive comment on "Sediment yield model implementation based on check dam infill stratigraphy in a semiarid Mediterranean catchment" *by* G. Bussi et al.

Anonymous Referee #4

Received and published: 2 May 2013

Measurement and prediction of sediment yield in semi-arid environments remains a major challenge for a large extent due to the erratic nature of erosion and sediment transport processes and the highly non-linear character of the sediment flux system. Models that are developed for temperate climates (eg RUSLE) therefore are very difficult to apply and more process-based oriented models require extensive calibration and field data, which are, however, mostly lacking. This study aims to provide such a model approach and uses a detailed record of sediment deposites behind a check dam to calibrate and validate a sediment yield model for a semi-arid mountainous Mediterranean catchment. However, in its present state, the paper has major shortcomings

that need to be addressed prior to final publication. I have listed my major concerns below.

First of all, this is not the first study that comes with a model to predict sediment yield from such environments. In the introduction, the authors refer to some other models but nowhere a critical discussion is provided making clear why these models are not suitable and why a completely new model approach needs to be followed. Why is it necessary to develop the TETIS model and include sediment transport ? Why not using the sediment archive data behind the check dam to calibrate/validate existing models ? In the end, we are not waiting for as much models as there are studied catchments. The authors need to make this clear in the introduction.

One of the main problems associated with more process-oriented models (compared to eg RUSLE approach) is that it requires a lot of field data and many parameters need to be (locally) calibrated. Here, the hydrological TETIS models requires 9 calibration parameters and the sediment sub-routine another 2. With 11 calibration parameters, it is not surprising to see that the model predictions are quite good: the more knobs you can turn, the better the result will be. But this doesn't mean that model really captures well what happens. In fact, the model is only calibrated at the outlet of the catchment so all internal processes are lumped: despite the fact that the model is said to be distributed, it is validated/calibrated in a lumped way and there is no guarentee that the various processes operating in the catchment are simulated well. This also means that exatrapolation of the model to other catchments will be very difficult lowering the potential of the model for predictions strongly. None of these defficiencies is really discussed. I also have doubts with the model calibration approach on page 3438. The soil moisture content at the end of an event is used as the initial state of SMC at the start of the next event. But, in semi-arid regions there can be a large time discrepency between two events and thus the SMC can have changed quite a lot. This is apperently not considered but it can have a major impact on the model predictions (and on the calibration coefficients). The authors also use the Nash-Sutcliffe model efficience to

evaluate the model. However, this method has a major drawback when the range in parameter values is much higher than the mean value: in that case it is more or less straightforward that ME is high. In this case, in a semi-arid environment with a few intense rain events, the range in Q is very high and a few high Q's are much higher than the average Q. Any model that more or less captures the runoff dynamics will predict much runoff after an intense rain event and thus it is logic that the predicted Q is higher than the average Q: the model will perform better than the mean and ME will be higher than 0. Figures like fig 6 should not be used to check the performance of models. It is better to plot the observed versus predicted value for either peak discharge or event runoff volume. The scatter on that graph will say much more on the behavior of the model than a temporal graph: off course when it rains Q goes up both for observed and simulated scenario's.

The sediment processes are seperated for hillslope and river domains. For the hillslopes, the authors use equations from engineering handbooks but these are not common at all within the geomorphic community: most erosion equations not only varies the parameter alpha but also the slope and discharge exponent; yet these are fixed in this approach. Why ? Many studies have shown that the slope and discharge exponent can vary a lot (see eg Prosser and Rustmomjii in Progress in Physical Geography, 2000) and this has a major impact on the resulting sediment fluxes. Why do the authors choose for these equations ? What is also not clear is how transport capacity is modelled. On the bottom of page 3433 and the top of 3434, they speak about 'residual' capacity and the possibility that sediment is remobilized or even that the soil erodes. But nowhere it is defined how TC is calculated and how residual capacity is calculated. This needs to be clarified.

Absolutely no details are provided on the STEP model. How was this done ? In the original STEP paper, check dams are not modelled so how did the authors do this ? Part of the method is explained in the results section (page 3441, lines 15-20) and should be moved to the methodology section. Nonetheless, more info is needed on

how STEP was used. Also lines 5-20 on page 3438 are in fact part of the methodology (of the hydrology model) and should not be places under the results section.

The authors provide no information on the spatial resolution on which the model is applied and thus also at which the input data were collected (figure 3). How accurate are eg soil hydraulic conductivities at higher spatial resolutions ? Is this realistic ? What is the impact of data input uncertainty on model outcome ? At present, no discussion on why the model predictions are not perfect is given but it would be interesting (and necessary) to see to what extent error in input data or rather an imperfect model approach are responsible for this.

No discusson on the accuracy of the sediment yield data obtained from the check dam is provided either. Furthermore, the description of the sediment archive is not only too wordy but also dispersed. Paragraph 3.2 describes the sediment infill but not the volume as the title suggests. Part of section 3.3 discussed the event stratigraphy whereby comparison with the model is made but a proper discussion of the event stratigraphy as such should be made prior to this comparison. I suggest to have a single paragraph on the observed sediment stratigraphy and discuss the sediment volumes with it (both total as per event). Based on figure 8 (the caption of fig 8 and 9 are switched) I wonder if the correlations made are all correct. Both trenches are located more than 20 apart and the spatial variability in sediment characteristics can very quite a lot. Eg: silt layer (unit 2) could be one layer as it is suggested here but it could also be a small pocket of silt deposited in a small pool but not as a continous layer.

paragraph 3.4 deals with sediment yield and the temporal variation in SY. This paragraph can be improved as well. Eq 5 is certainly not proposed by Bellin et al but is a standard approach for calculating SY from dam sediments that is used much longer. It would be revealing to see a temporal graph with declining TE and varying SY. It is stated that the two predictions of total SY are in close agreement but the opposite would be surprising as both calculations use the same assumptions and model outcomes. Since the model is calibrated on the total sediment volume and also TE is calibrated, it is thus

logic that both values are more or less identical. The authors state the modelled texture of deposited sediment agrees with field measurement but nowhere data is shown to illustrate this and that could support this.

Although the paper is relatively well-written, it is advised that a native speaker goes through the manuscript prior to resubmission. Especially from 2.2 on there are still many linguistic errors.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 3427, 2013.

C1381