

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

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We would like to thank the referee #3 for its very useful comments. We will try to include most of his/her suggestions into the final version of the paper.

Comment: 1) A major comment is that the model performance is highly dependent on the STEP model implementation into TETIS. It is unbalanced to provide 2 pages of information in M&Methods on the TETIS model equations (a model already published) and not include a similar level of detail on STEP. This should be revised to provide your colleagues with a more clear description of the model used.

Answer: We decide to emphasise the description of the TETIS sediment sub-model because its conceptualisation has not been published yet, while both the hydrological component of the TETIS model [Francés et al., 2007] and the STEP model [Verstraeten and Poesen, 2001a] have already been described in literature. We dedicated 20 lines to the TETIS hydrological sub-model, 2 pages to the TETIS sediment sub-model and 8 lines to the STEP model. In any case, we understand the key importance of the STEP model, and will provide the following description in the final version of the paper.

The TETIS model was coupled with a reservoir sedimentation model, in order to reproduce the sedimentation dynamics of a small reservoir or check dam during a flood event. An existent model, called Sediment Trap Efficiency for small Ponds (STEP, Verstraeten and Poesen [2001a]), was adapted and coupled to the TETIS model. The advantages of this model are: i) its conceptualization is simple and parsimonious, and requires a small amount of data; ii) it is one of the most recent reservoir sedimentation models that can be found in literature; iii) It was developed for small ponds; iv) it was developed for long term trap efficiency estimation and for continuous simulation; v) it is compatible with the TETIS model, given that it only requires the inlet water and sediment discharge as input, which can be provided by TETIS. As for other models, the STEP model divides pond into several finite volumes (originally called chambers). For STEP this is done on the basis of equal surfaces. Water is routed from volume to volume by means of a simple mass balance equation. The original STEP model can take into account the effect of the reservoir bottom slope, although no complicated hydraulic conditions, such as an irregular pond shape, can be reproduced [Cheng, 2008]. In this study, the STEP model was adapted in order to model any reservoir by introducing an elevation-volume curve.

Sediment routing is also carried out by solving a mass balance equation for each volume, taking into account the settling velocity of each particle (Chen [1975]). The portion of deposited/transmitted sediments is computed for each volume. The deposited and outflow sediment masses for each finite volume need to be corrected because the sed-

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iment that is deposited cannot be transmitted to the next finite volume, and vice versa. This is done by taking into account the critical water depth for sediment deposition and the ratio of transmitted water volume to the actual water volume in the finite volume. The critical depth is defined as the maximum depth at which the trap efficiency is 99% during the whole time step, for turbulent conditions. This value is different for each textural class.

Comment: 2) It is unclear how the C and K values were generated and their actual values in the model calibration. I would suggest complementing Figure 3 with a Table indicating the C and K values distribution (e.g. average, stdev ...) and units, as well as the change of during the “window of disturbance” mentioned in page 3436.

Answer: We will include the following text in the final version of the paper. The C [-] and K [t ha h ha⁻¹ MJ⁻¹ mm⁻¹] values were taken from a previous study [Antolín Tomás, 1998], unfortunately not available in English. The C value was estimated depending on the vegetation type and the cover density following the guidelines by Wischmeier and Smith [1978] and Dissmeyer and Foster [1984]. The K factor was estimated from soil analysis (texture, organic matter and salinity) of a dataset covering the whole Valencia Region, following the equation proposed by Wischmeier and Mannering [1969], and then interpolated in space. The C and K value did not change with calibration, because in this study only the sediment transport capacity was calibrated (alpha and beta coefficients, page 3433).

Within the Rambla del Poyo catchment, the highest C values (0.32) are located in the headwater, especially in the check dam sub-catchment, and correspond to the less dense shrubland areas. The smallest values (0.1) are also located in the headwater, and correspond to small areas of pine forest. The intermediate and lower parts of the catchment are characterised by values around 0.2. During the chosen windows of disturbance, the C value was changed to 0.9 in the area affected by wildfires, similarly to what was done by Rulli et al. [2005].

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The K values decreases from the lower floodplain towards the headwater, mainly due to the content of sand of the soil (up to 50% in the lower part and decreasing up to 10% in the headwater, following Rubio et al. [1995]).

K USLE: min: 0.1, max: 0.45, mean: 0.275, St.Dev. 0.1024

C USLE: min: 0.104, max: 0.318, mean: 0.24, St.Dev. 0.059

Comment: 3) A minor detail in page 3437, accuracy of the GPS used.

Answer: We employed a RTK (Real Time Kinematic) GPS. The global scale error was around 6 m, while the relative accuracy was 1.5 cm (horizontal accuracy) and 1.8 cm (vertical accuracy). We will include these data in the final version of the paper.

Comment: 4) It is unclear why such a key variable such as the dry bulk density of the infill deposit (page 3441) was estimated from a procedure from 1943 and not measured, or at least the estimations validated, in the profile descriptions of the sediment area within the check dams during the pit excavations.

Answer: Unfortunately we cannot provide an observed value of the dry bulk density because we did not carried out any measurement during the field activities. We chose the Miller formula because it is suggested by almost all hydrology and sedimentation handbooks (e.g. Chow [1964]; Vanoni [1975]) and we don't know any other better. This methodology can certainly be criticised, and has many limitations [Verstraeten and Poesen, 2001b]. Nevertheless, given the available data, this approach can be considered the most reliable one between all the dry bulk density estimation formulae, especially for normally dry reservoir (Verstraeten and Poesen [2001b]). But the reviewer is correctly stating that this is a key variable and we will include this justification in the revised version of the paper.

Comment: 5) In the sediment yield evaluation, I misses the use of the same index (Nash-Sutcliffe index) used to evaluate the performance of runoff predictions. This, or a different index indicating why is not the NSE, should be used to improve the evaluation

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of the model performance presented in Figures 11 and 12.

Answer: The NSE index cannot be calculated on the sediment discharge series, due to the lack of observed data. Nevertheless, a NSE index can be estimated by comparing the simulated sediment volume (from model results) and the observed volume (from the stratigraphical description). The result is 0.872 if comparing the model results with the volumes estimated by the wedge approach and 0.609 if comparing them with the proportional approach results. We will incorporate this index result to the revised version of the paper.

Comment: 6) Since there is no indication of textural distribution of the topsoil in the catchment, it is very difficult to interpretate the discussion in the first paragraph of sediment yield (3.4) and some other parts of the manuscript. This information should be included in section 2.2. (Study area).

Answer: The topsoil texture, which was taken from the LUCDEME project data [Rubio et al., 1995], is silt loam for headwater soils (around 20-60-20% of sand-silt-clay percentage respectively, following the USDA classification). The content of sand gradually increases from west to east. In the lower catchment, the mean texture is clay loam (around 30-40-30%), although sandy loam areas can also be found. The mean texture of the check dam catchment (20-60-20%) does not correspond with the reservoir deposit texture, which is much sandier, because only the coarser material is trapped into the check dam. Nevertheless, the simulated deposit texture is very similar to the observed one (which was measured in this study), as stated in the text. This observation suggests that the sediment trap efficiency sub-model is working properly. We will include this description in the corrected version of the paper.

Comment: 7) The manuscript, for not been a review paper, seems to be over referenced (76).

Answer: We understand that the number of references is quite high, although it does not seem to be clearly higher than other papers in HESS. We would also like to know

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the editor's opinion on this point, in order to be consistent with the journal standards.

Comment: 8) The English use in the manuscript, albeit good and understandable, presents some structures that should be revised by an English native speaker. I can identify some of these structures as probably non-correct, but since I am not a native speaker I cannot correct with confidence those sections.

Answer: We will improve the manuscript by revising carefully the grammar style.

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