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Hydrology and Earth System Sciences Discussions

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 reviewer for his very interesting comments, which will improve significantly the value of our paper. We will include his comments in the final version of the paper.

PAGE 3435 – LINE 25

Comment: The current shrubland is not only due to the fire recurrency. In my opinion, the long agriculture and livestock use of the mountains is the deep reason to the shrubland cover. Those mountains were used for forage, biomass, and agriculture

for milennia, and this is why the potential or climatic vegetation of Quercus Ilex is not present anymore.

Answer: As the reviewer states, wildfires are not the only cause of the presence of shrublands in Mediterranean catchments. Land abandonment during various decades of the 20th century and the previous intensive livestock use should also be considered as other potential causing factors. This phenomenon was observed and addressed by many authors, e.g. Cerdà (1998a), Rey Benayas et al. (2007) and Baeza et al. (2007), for Mediterranean environments located close to the Rambla del Poyo catchment. Although these considerations do not affect the core of the paper, we will add a statement in the new manuscript.

PAGE 3436 – LINE 24 and PAGE 3436 – LINE 26

Comment:The authors must highlight here that fire reduce the infiltration rates and increase the surface wash (Cerdà, 1998a), but also that the fire affected land is recovered and that the soil losses are control after 2-4 years (Cerdà, 1998b). Cerdà, A. 1998a. Changes in overland flow and infiltration after a rangeland fire in a Mediterranean scrubland. Hydrological Processes, 12, 1031-1042. Cerdà, A. 1998b. Postfire dynamics of erosional processes under mediterranean climatic conditions. Zeitschrift für Geomorphologie, 42 (3) 373-398. Recent findings demonstrate that the increases in the soil losses after the forest fires are not sudden. After a forest fire a layer of ash acts as mulch and reduce the soil erosion rates, but this is an ephemeral response, as soon the ash is washed and the erosion rates extremely high. See: Cerdà, A. y Doerr, S.H. 2008. The effect of ash and needle cover on surface runoff and erosion in the immediate post-fire period. Catena, 74 , 256- 263. doi:10.1016/S0341-8162(02)00027-9

Answer: As stressed by the reviewer, a wildfire usually increases the erosion rates due to the reduction of the infiltration rate, the increase of surface runoff and the increase of soil erodibility (Cerdà et al., 1998b), among other effects. It has been demonstrated that, for Mediterranean plots similar to the Rambla del Poyo headwater, the site recovery is fully achieved after 2-4 years (Cerdà, 1998c) and that the most important alteration of the usual runoff and erosion rates occurs within a few months after the fire, depending on the precipitation (Cerdà, 1998b,c and Andreu et al., 2001). In our study, we adopted a window of disturbance lasting from a few months to a few years, depending on the occurrence of the first extreme precipitation events. The C factor of USLE was modified during the windows of disturbance, but not the infiltration capacity. This was done because the hydrological sub-model was calibrated correctly and validated without taking into account the eventual infiltration capacity decrease, and there was no evidence of such an effect when comparing simulated and observed water discharge. We think that a possible reason for the absence of infiltration decrease is the one suggested by Cerdà and Doerr (2008), which stated that, after a forest fire, the layer of ash may compensate the effect of infiltration capacity reduction. In the Rambla del Poyo catchment we observed a similar behaviour: the comparison between the model results and the observed water discharge suggests that no sudden increase in runoff took place after the wildfires. These considerations will be included in the final manuscript.

PAGE 3437 – LINE 5

Comment: This will probably reduce the representativeness of your data. But, we must be positive, and agree that your research will show the maximum erosion rate in the area.

Answer: The studied check dam was chosen for its accessibility and because it held the longest sedimentary record. Other check dams were found within the catchment, with similar or lower siltation rates. These check dams were described in Bussi et al. (2012). In that study, the remaining check dam sediment deposits were used for spatial validation of the model, showing good agreement, although no stratigraphic description was carried out. For this reason, the reviewer correctly states that our study will show the maximum erosion rates in the areas, although we know that the erosion parameters can be reasonably extended for the whole Rambla del Poyo headwater.

We are now considering whether including the remaining check dam results into this paper or writing a new paper concerning spatial variability of soil erosion.

PAGE 3444 – LINE 14

Comment: I highly suggest to use Mg instead of t as this is the right Metric System parameter, but it is OK if HESS agree. And I will say that Mg ha-1 y-1 is the right way to show this data (just /100 to have the right value) This is just a suggestion, but I found that in this way the reader will understand better the information.

Answer: We will use Mg ha-1 y-1.

DISCUSSION section (3 comments)

Comments: 1 - I wish to suggest that the discussion can be enlarged as the results are very inspiring. The soil losses measured are of 0.1 Mg ha-1 y-1, which is very low. This does not agree with the traditional view of the soil erosion in Spain, that uses to show very high erosion rates. The research of some colleagues in Eastern Spain shows that limestones are having a high infiltration rates, and then, the surface wash is very little. Most of the river flows are coming from subsurface flow, which explain the low erosion rates See this publication as an example of the erosional and hydrological response of calcareous soils on Limestones. Cerdà, A. 1997. Seasonal Changes of the Infiltration Rates in a Typical Mediterranean Scrubland on Limestone in Southeast Spain. Journal of Hydrology, 198 (1-4) 198-209 2 - I think that the discussion can be improved The soil erosion rates are low due also to the vegetation recovery after the land abandonment. Likely, soil erosion is triggered after the abandonment, but the vegetation recovery favours the soil erosion control Cerdà, A.1997. Soil erosion after land abandonment in a semiarid environment of Southeastern Spain. Arid Soil Research and Rehabilitation, 11, 163-176. 3 - And a third topic that can make more valuable your discussion is to mention that forest fire do not trigger extremely high erosion rates for land periods of time such as your information says, but that they trigger a window of disturbance that make the soil losses high during short periods of time See: Cerdà, A. & Lasanta, A.

2005. Long-term erosional responses after fire in the Central Spanish Pyrenees: 1. Water and sediment yield. Catena, 60, 59-80

Answer: The TETIS model results show a specific sediment yield of 0.14 Mg ha-1 y-1 for a 12.9 km2 catchment with shrubland cover and calcareous soils, which is considered as low erosion rate for Mediterranean areas (the study by González-Hidalgo et al., 2007, may be used as a reference of erosion rates in the Mediterranean areas). For example, Boix-Fayos et al. (2005) found that 1 Mg ha-1 y-1 was one of the lowest erosion rates recorded in the SE of Spain (especially within the Murcia and Almeria provinces) at the catchment scale. This low erosion rates in shrubland catchments with limestone geology were also observed by other authors, such as Kosmas et al. (1997). The main reasons of this difference are the land cover and the lithological origin of the soil. As stated by Cerdà (1997a), soils originated from limestone have high infiltration rates especially during the dry season, reducing the direct flow on the hillslopes and thus decreasing soil erosion. Furthermore, the homogeneous shrubland cover also has a positive effect on land degradation (Cerdà et al., 1998b), although it increases the risk of fire. This dynamics is typical of many Mediterranean catchments, which suffered strong land abandonment during the 1960s, inducing firstly accelerated land degradation and later the development of a shrubland cover, as is the case of the Rambla del Poyo catchment. This behaviour was noticed in various studies, such as Cerdà et al. (1998b), Rey Benayas et al. (2007) and Baeza et al. (2007). As stated before, shrubland catchments are subject to frequent fires. The wildfires increase the erosion rates, which would be otherwise rather low, during a variable period of time until full recovery (between 2 and 4 years, following Cerdà et al., 1998c). An example of this phenomenon can be found in Cerdà and Lasanta, 2005. The authors demonstrated that in a shrubland catchment under natural conditions the erosion rates are low (0.04 – 0.1 Mg ha-1 y-1 in this case, similar to the Rambla del Poyo specific sediment yield), but they can increase up to 10 times within the 2-3 years after the fire. For the Rambla del Poyo catchment, no information about fire intensity, duration or ash production was available. In order to reproduce the effect of erosion increase during a windows of

disturbance, the 1994 and 2000 fires (the fires affecting the check dam catchment) were modelled by increasing the C factor of the USLE for the extreme events occurred in the following 2 years (December 1995 for the 1994 fire and October 2000 for the 2000 fire), corresponding with the highest peak of erosion increase. We assume that the error introduced with this approximation is corrected by model calibration. All these considerations will be included in the final manuscript.

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