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Hydrology and Earth System Sciences Discussions

Interactive comment on "Extreme runoff response to short-duration convective rainfall in South-West Germany" *by* V. Ruiz-Villanueva et al.

V. Ruiz-Villanueva et al.

v.ruiz@igme.es

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Answer to Reviewer No. 3 of: Extreme runoff response to short-duration convective rainfall in South-West Germany, by Ruiz-Villanueva et al.

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Introduction We would like to thank Dr. A. J. Teuling for his detailed review of our manuscript. His comments are addressed in the following response and the manuscript is being revised to accommodate the changes. Following his recommendations we strengthened the section dedicated to the hydrological modeling and we provided data and model results regarding five less extreme flood events. A more general discussion about the invariant celerity assumption for both the channel and the hillslope system is also reported.

1 General comments Comment 1.1. In the model, presented by Equations (3) and (4), it is assumed that channel flood and hillslope celerities vc and vh are constants. In reality, however, the hillslope celerity will depend on the local slope as well as on the thickness of the water layer. Both of these quantities will vary throughout the catchment, but moreover they will likely correlate with the flow distance to the catchment outlet. The impact of the assumption that vh is a constant on the simulated discharge should at least be discussed.

Response We introduced the following discussion in the revised version: "The use of invariant channel and hillslope celerities requires some clarification. Pilgrim (1976), using tracer studies, showed that the average flow velocities are a nonlinear function of the discharge, but reach an asymptotic value at high flows. This supports the assumption that models of the hydrologic response employing invariant channel celerity explain observed travel time distributions, at least for high flows conditions. The invariant hillslope celerity assumption is more conceptual in nature (Botter and Rinaldo, 2003). In fact, great variability in hillslope transport properties is expected, particularly when it is driven by local topographic gradients as subsurface runoff through partially saturated areas and in the presence of preferential flow paths (e.g., Beven and Wood, 1983; Dunne, 1978)."

Comment 1.2. While the model is calibrated on the discharge extreme, the performance of the model in simulating less extreme discharge events is not discussed. It would strengthen the claim made by the authors that the discharge peak was extreme (made in manuscript title) if they could show through modelling that in fact the runoff processes were significantly different due to the high rainfall intensities than during "normal" discharge peaks.

Response Accordingly to his suggestion we provided new model results regarding five less extreme flood events. We added a new Figure (now Figure 10 a and b in the revised manuscript) showing a comparison between observed and simulated hydrograph at Rangendingen for two flood events occurred on: a) August 11, 2002 and b) July 23, 2010; and we provided a new table (Table 2 in the new version) as well with the rainfall and runoff properties for the five moderate flood events occurred between 2002 and 2010.

Based on these analyses we revised the text as follows: “To examine the performance of the model in simulating different floods, the model was applied to five flood events selected in the period 2002 to 2010 (Table 2). The considered floods are those exceeding a threshold of 25 m3 s-1 peak discharge in Rangendingen, and occurred in the following periods (date of the flood peak is reported): May 4, 2002; August 11, 2002; June 21, 2007; June 18, 2008; July 23, 2010. These are moderate events, considering the catchment flood regime. The model parameters were kept constant, with the exception of those describing the antecedent soil moisture conditions, which were calibrated to represent the initial soil moisture status. After consideration of antecedent rainfall and runoff values, these parameters were kept constant on the five floods. Model results were relatively good, when one takes into account that the model calibration was carried out on an extreme flood which may be representative of hydrological processes not observed during ‘normal’ events. Observed and simulated flood hydrographs are reported in Fig. 10 for the events of August 11, 2002 and July 23, 2010, which represent a range of model results, respectively. The comparison shows that the timing of the flood peak is well simulated in the modeled hydrographs. On the other hand, the recession limb and the volume is less accurately portrayed. Overall, this indicates that runoff propagation is modeled in a robust way, whereas the estimation of the runoff volume in some cases is more uncertain. However, these model results shows that parameters identified on an extreme event may be transported to less extreme cases, when initial conditions are properly accounted for. Examination of the distribution of the event runoff ratio in the following sections provides a partial explanation for this finding. “

2 Specific comments Comment 2.1 Page 10747, Line 23: Change “right-hand” into “eastern”. Response This has been corrected in the text.

Comment 2.2 Page 10749, Line 23: “indicates indicate” Response This has been corrected in the text.

Comment 2.3 Page 10757, Line 22: Change “percentage” in “fraction”. Response This has been corrected in the text.

References:

Beven, K., and Wood, E.: Catchment and geomorphology and the dynamics of the runoff contributing areas. J. Hydrol., 65, 139– 158, 1983. Botter, G., and Rinaldo, A.: Scale effect on geomorphologic and kinematic dispersion. Water Resour. Res., 39(10), 1286, doi:10.1029/2003WR002154, 2003. Dunne, T.: Field studies in hillslope flow processes, in Hillslope Hydrology, edited by M. J. Kirkby, pp. 227– 294, John Wiley, Hoboken, N. J., 1978. Pilgrim, D. H.: Isochrones of travel time and distribution of flood storage from a tracer study on a small watershed. Water. Resour. Res., 13(3), 587– 595, 1977. Pilgrim, D. H.: Travel times and nonlinearity of flood runoff from tracer measurements on a small watershed. Water. Resour. Res., 12(4), 487–496, 1976.

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