

Interactive comment on “Effects of antecedent soil moisture on runoff modeling in small semiarid watersheds of southeastern Arizona” by Y. Zhang et al.

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Thanks to the reviewer for the insightful comments. The review certainly helped in stimulating our thinking. The paper will be much improved as a result.

1. Reviewer comment: Reading the paper it is not clear which is the reason of the main finding of the paper, i.e., the low influence of ASM conditions. In my opinion, this is mainly related to the very low variability of ASM conditions between the events, not to the low RHEM model sensitivity to ASM. This aspect could be investigated comparing the variability of the rainfall depth and ASM values between the events. For

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instance, the valued of the coefficient of variation of each sample can be investigated. Moreover, the sensitivity analysis of the RHEM model is only briefly analyzed (7 rows) without giving information on the relative magnitude of the obtained sensitivity indices (if compared, for instance, with the range of variability of runoff volume and peak discharge for the selected events). These aspects should be better analyzed in the revised manuscript.

Author response: Agreed. I believe that the reviewer is correct that the low sensitivity of runoff depth to ASM in this case is due to the low variability of ASM. We had been thinking simply of it in terms of the fact that the ASM was always more or less dry, in other words, low variability on the dry end of the scale. Probably the idea is better expressed as one of low variability in ASM, this case being due to constantly dry (and quickly drying) conditions. This actually also relates to other comment below and of the second reviewer in that in this environment only the very top layer of soil usually is wet during an event (in summer, when most runoff occurs), and hence A) it dries quickly and B) the top 5 cm layer is the appropriate layer to consider for this case in understanding ASM effects on infiltration. The next point this comment brings to mind is that there will always be some variability in the response of runoff to a given ASM. The question then is how the magnitude of the variability of the ASM compares to the variability of runoff response to ASM. If the two CVs are of the same order then of course one would not expect to see and ASM effect – it would be clouded by the “natural” variability of the runoff response for a given ASM. The reviewer suggests comparing ASM variability to variability of runoff volume and peaks. This can certainly be done, but I wonder if an additional approach might be to look at variability (CV) in runoff ratio in sets of very tight ranges of ASM (e.g., 1%) (and perhaps rainfall amount, if there is enough data to allow that) compared to the overall ASM variability? We will explore both options.

2. Reviewer comment: The content of the conclusions of the paper is not usual. I expect to found the summary of the obtained results together with the possible analysis for further studies. From page 6239, line 21 to page 6240, line 14 the reference to

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previous studies is given. This part is more appropriate for the Introduction section or, at least, in the Discussion.

Author response: OK, we can fix the conclusions as suggested.

3. Reviewer comment: The description of the RHEM model should be enhanced. Much details are given for the erosion module that, however, is not used in this study. I understand that the model was developed with this purpose but, in my opinion, less emphasis should be given to the "erosion" part. Moreover, in the description of the model parameters, it was made confusion between parameters and input data. Rainfall and ASM conditions are input data, not parameters (to be estimated). Soil texture, slope lengths and gradients are not parameter but physical characteristics of the watershed. How are they used for model parameter estimation? Please be more precise in the description of this part because model parameterization represents an important part of the paper. Author response: OK, we can fix that. We can be more precise in the description of the model parameterization.

4. Reviewer comment: The RHEM model is able to simulate the whole flood hydrograph for the rainfall runoff events analyzed in the study but very little information are given for the model capability to simulate the shape of the hydrographs. This aspect is also related to the parameters used for runoff routing (on the channels and hillslopes) for which no information is given in the paper. I would like to see the model simulations for some exemplary hydrographs (e.g. for dry and wet ASM conditions) to deepen the model reliability if constant or variable ASM conditions are used.

Author response: Regarding the request for more detailed analysis of the routing routines and capabilities of RHEM, there are two problems. 1. The data that we are using are from small watersheds that have variable degrees of active channel processes in effect. RHEM, on the other hand, is a hillslope model. RHEM does have runoff routing on the hillslope scale, but we do not have a channel component in RHEM. This was intentional in the design of the model because firstly it is intended to be usable as a

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component of watershed models (we have already incorporated the RHEM hillslope routines into KINEROS) and secondly our focus for this model is related to onsite soil and vegetation management at the hillslope scale. This is not a major problem in terms of looking at volumes of runoff (excess rainfall minus recession infiltration), but I am not confident that the RHEM model alone would be appropriate for assessing its capability to replicate hydrographs for these data. In other words, our intention in this study was to focus on infiltration and runoff amounts rather than routing. 2. If we were to look at the hydrographs in detail that would require some calibration or assessment of friction factors, which we are not prepared to do at this stage. We are currently in the process of putting together another paper specifically on friction factors for RHEM based on hillslope-scale field experimental data.

5. Reviewer comment: A further analysis that can be easily carried out by the authors is related to the use of "optimal" ASM conditions and to analyze the model performance in terms of flood peak estimation (or Nash-Sutcliffe coefficients for the simulated hydrographs). For "optimal" ASM conditions I intend the use of the soil moisture value that exactly reproduce the observed runoff volume for each rainfall-runoff event. In fact, the similar results in the model performance by using constant or variable ASM conditions could be linked to the uncertainties of the measured soil moisture values. The use of "optimal" ASM conditions gives the upper bound of the model performance, if in this case the performance are significantly better than those obtained in the simulations carried out in the paper it should mean that the uncertainties of observed soil moisture values are high. Therefore, the use of measured values does not increase model performance due to their uncertainties.

Author response: This is a good idea if one were to be able to assess the routing (hydrographs). If I understand correctly the suggestion, and considering the above comments related to the hydrographs, I don't see a way to follow this path. As the reviewer correctly indicates, one should be able to find the ASM value that gives a "perfect" match to runoff volume for every event. After that, without looking at peaks or

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hydrographs, there is little left to do with that information, I think.

Reviewer comment: Specific Comments/ Technical Corrections (P: page, L: line or lines)

Author response: Agreed. The editorial changes will be made as suggested.

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