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Hydrology and Earth System Sciences Discussions

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

Anonymous Referee #1

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Overview

The study investigates the role of Antecedent Soil Moisture (ASM) conditions on runoff generation for four very small semi-arid watersheds (0.34 to 4.53 ha) located in the Walnut Gulch Experimental Watershed, Arizona (USA). Specifically, rainfall, runoff and soil moisture observations are collected for a series of rainfall events occurred during the period 2002-2010. The Rangeland Hydrology and Erosion Model (RHEM) is hence applied and tested with the collected data sets with particular attention to the role of ASM conditions. Results show that for the specific climatic setting of this study, ASM

conditions play a minor role for the estimation of runoff. If the RHEM model is initialized with a constant (long-term average) soil moisture value, the outcomes are the same than by using measured (variable) soil moisture data.

General Comments

With pleasure I have read this paper, which I found to be very interesting because it addresses an important topic for catchment and operational hydrology. In fact, the understanding of the soil moisture role for different climatic regions worldwide has important consequences for the effective use of soil moisture data in rainfall-runoff modelling. The recent increased availability of these data sets from in situ observations and also remote sensing sensors offers new possibilities to improve runoff prediction and forecasting. However, it is yet needed to know for which zones the benefits could be higher.

In this study, by using actual and reliable observations, the authors obtained the not common, and hence important, result that ASM conditions are not an important factor for runoff prediction in the investigated area. Moreover, the public availability of the employed data sets represents a further added-value of the study because this allows the reader to better understand and, possibly, reproduce the results. Despite the paper merits, I found some issues to be solved before its publication.

1. 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 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

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of runoff volume and peak discharge for the selected events). These aspects should be better analyzed in the revised manuscript.

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

3. 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.

4. 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.

5. 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

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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.

In the specific comments, I report a number of further changes and clarifications that are required.

On these bases, in my opinion, I find that the paper may become worthy of publication on HESS after a moderate revision.

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

P6229, L13: Change "can be" with "is".

P6229, L14: Remove "also".

P6232, L12: Please add the link to the website where the data can be downloaded.

P6233, L14-15: "Linear regression ... measured runoff.". Remove this sentence.

P6234, L15: Specify acronym DEM.

P6235, L11: Formatting error.

P6236, L1: Please be consistent in the definition of the Nash-Sutcliffe index. In Tables it is defined as Nash-Sutcliff.

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P6236, L12: Why 186 runoff hydrographs? and not 240 (=60*4).

P6236, L15: Remove "on 3176 days".

P6236, L19: Change "rainfall-runoff events" with "runoff hydrographs".

P6237, L8-9: "Most of the simulated... predicted values.". Remove this sentence because obvious.

P6238, L5-8: This sentence is not clear and should be explained better.

P6239, L18-19: Goodrich et al. (1994) analyzed the sensitivity of runoff to the spatial variability of ASM conditions. Please specify better.

P6241, L14: Change "Hydrol. Processes" with "J. Hydrol.".

Figure 4: I would like to show the x-range for effective hydraulic conductivity between 0 and 20.

Figure 9: I would like to show the x-axis as a sequel of category data (not dates) to make the figure more readable.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 6227, 2011.