Hydrol. Earth Syst. Sci. Discuss., 8, C3366–C3370, 2011
www.hydrol-earth-syst-sci-discuss.net/8/C3366/2011/

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.

Y. Zhang et al.

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Received and published: 10 August 2011

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.

Comment or reviewer - The paper needs to be strengthen in its structure and results discussion, much more emphasis should be given to the runoff production mechanisms and modeling. One possible explanation for the obtained results (no correlation between ASM and runoff) may be due to the fact that the recorded events differ significantly in rainfall intensities and this may produce a result like this, but this or other hy-

potheses are not investigated or taken into consideration. In my opinion, author should try their best in order to provide a reasonable and physically consistent explanation for their results.

Author Response: Agreed. This comment corresponds to a large extent the comment of the first reviewer regarding the variability of the ASM as an explanation for why these results were so. The low sensitivity of runoff depth to ASM in our case is probably 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 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. There will always be some variability in the response of runoff to 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 first reviewer suggested 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

Comment of reviewer: âĂć The first point refers to the main result of the paper that is also the title of the work. The effects of antecedent soil moisture on runoff production is investigated using modeled data, but authors have almost all they need as rough data measured in the field. What is the need to use a model in this case? Everything is already there.

Author Response: Perhaps, but we really felt that it is necessary to have a physical representation of the processes in order to see in the most detailed manner possible if

runoff was sensitive to the ASM. I think that it would be difficult to make our case in a definitive way without using some sort of mathematical representation of the processes, or at least we would be making a less convincing argument. In addition, our focus also is on improved parameterization of the model considering tradeoffs between model complexity and model error.

Comment of reviewer: âĂć My second point is again a general comment on the used approach. The results of this work are uncertain for a number of reasons: the first of all is the modest variability observed in the ASM. The second refers to the uncertainty of the model that produces one result of the many feasible results possible using slightly different parameters. I understand that in this case only one parameter was calibrated, but several were assigned in using a deterministic approach while some uncertainty is always present.

Author Response: Yes, agreed to the first point, which we addressed above to the first comment. With regard to other parameters, the most important would certainly be the soil matric-potential term. One could in theory attempt to optimize for both parameters simultaneously, but in my experience with Green-Ampt, because of the co-dependence of the output response (runoff volume) to the two input terms, one will obtain a very elongated valley on the plot of the objective function (e.g., least square difference summation) plotted on the Ke vs. suction axes. This means that there will most certainly be a range of paired values of Ke and suction parameters that will give you essentially the same runoff response. My experience with Green-Ampt is that this is not a fruitful pursuit, unless one wants to look specifically at the co-dependence of the two variables on runoff response.

Comment of reviewer: âĂć According all my reasoning above, my major doubt regards the ability of this approach to interpret correctly the surface runoff component (I assume that the term runoff in the paper refers to the surface runoff in order to be coherent with previous studies on this topic). Looking at the hydrographs it seems that a significant subsurface runoff component in the discharge is present. This has two implications

one regarding the soil wetness of the basin that probably is wet enough to create such component and the second regards the modeled runoff that should keep separated the two components (surface and subsurface). A possibly strategy cope this issue is to separate low flow from surface runoff. One may use to this end the physically based filter proposed by Furey and Gupta (2001), but many are available in the literature.

Author response: I can see that we need to clarify the description of the hydrologic environment to a greater degree. This is a semi-arid environment with caliche (strong calcium carbonate layer) at about 60 cm depth. There is zero lateral subsurface flow in this environment. The streams in this area are “losing streams” with runoff over larger areas dominated by channel transmission loss. There is no subsurface contribution at all in these watersheds. We are very sure about that as we have been collecting data here for 30+ years. We need to clarify the hydrological conditions better in the paper.

Comment of reviewer: âĂć The authors used for their elaboration measured soil moisture at 5cm of depth. This measure may be significantly different from the dynamics of SM over the active soil column. Consequently, the soil moisture measured at 5cm of depth may not affect significantly the infiltration process. So, one suggestion is to test the relationship using the ASM integrated over different depths.

Author Response: We tried the 15cm depth as well as the 5 cm. The fact of the matter is that in this environment, which has an extremely high ET rate and, for the high intensity summer rainfalls that caused all runoff over the period of study (and in general) it is the upper 5 cm that is controlling the infiltration process here.

Comment of reviewer: âĂć The sensitivity analysis described in the paper is somewhat useless considering the limited range of variability of soil moisture adopted. Moreover considered the limited sensitivity of the model to the ASM it is almost obvious that mean or actual ASM does not make any difference in runoff simulation.

Author Response: I would suggest that the point is not that the sensitivity analysis is useless, but that the small range (variability) in ASM actually present in this environ-

ment is small, which is why the SM variability is of relatively low influence. The first reviewer also brought this up. It is a good point, and we agree. Our response to this is basically what we stated in the first comment above. We need to do, and will do, an analysis looking at the variability of the ASM relative to the variability of rainfall and runoff.

Comment of reviewer: âĂć Conclusions should be focused on the results of the research, while the discussion on previous works should be moved to the intro or in the discussion. Conclusions only focus on one of the results of the research and in particular on the fact that the runoff amounts and peaks simulated with long term average soil moisture were statistically equivalent to those simulated with measured antecedent soil moisture. Why?

Author Response: Yes, the reviewer is correct that we need to improve the conclusions statement to better reflect the results of the research. This comment was made also by the first reviewer. We agree.

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