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Hydrology and Earth System Sciences Discussions
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Interactive comment on "Does the simple dynamical systems approach provide useful information about catchment hydrological functioning in a Mediterranean context? Application to the Ardèche catchment (France)" *by* M. Adamovic et al.

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Note: for brevity, I shorten "simple dynamical systems approach" to "sdsa" and e.g. "page 10725, line 4" to "25-4".

General comments (HESS manuscript evaluation criteria)

1. Does the paper address relevant scientific questions within the scope of HESS?

Yes. The sdsa is an elegant new method and very powerful if it works. Many people try it and some succeed. It's good to get some examples in the literature showing when and where it does yield satisfactory results - and when and where it doesn't.

2. Does the paper present novel concepts, ideas, tools, or data?

Yes, this paper gives valuable new insights into the sdsa, even though it is mostly a new application of an existing method.

3. Are substantial conclusions reached?

Yes.

4. Are the scientific methods and assumptions valid and clearly outlined?

Yes.

5. Are the results sufficient to support the interpretations and conclusions?

Yes.

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?

Yes, although the ET and P rescaling procedure could be clarified.

7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution?

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Yes.

8. Does the title clearly reflect the contents of the paper?

I think the title could be adapted to better fit the contents. You didn't investigate in depth whether the sdsa "provides useful information about catchment hydrological functioning". I can imagine that that is what you set out to investigate, but before being able to answer that question, you had to analyse if the sdsa would work at all and that's what most of the paper is about (which is sufficient). You do get back to the question on hydrological functioning a little in the discussion, but I still think it a secondary question. I would therefore advise to change that part of the title to "yield satisfactory results" or something similar.

9. Does the abstract provide a concise and complete summary?

Yes.

10. Is the overall presentation well structured and clear?

Yes. I always like it when Subsection headers in the Methods and Results Sections are the same, so that when I am confused in the Results Section, I can easily find the explanation in the Methods Section. You kept this symmetry nicely. (Maybe it can be further improved by choosing either "simulation" (3.2) or "simulations" (4.2) for both 3.2 and 4.2, and "Rainfall" (3.3) or Precipitation (4.3) for 3.3 and 4.3, but these are unimportant details.)

11. Is the language fluent and precise?

Yes. I found it very well-written – I never had to read sentences twice.

12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?

Generally, yes. Some minor things:

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- In Eq. 18, the mean of the observed discharge Y_i^{mean} should not include the subscript i. You could (if you like) also add "obs" to the superscript to make clear that it's the mean of the observations (although it is specified below the equation).
- In Eq. 19, you can remove the outer brackets and the brackets around the 100. Maybe also mention that the 100 is for scaling to percents.
- The Nash-Sutcliffe Efficiency is first abbreviated as NSE and later as NASH.
- c_1, c_2 and c_3 are first in small font and later in capitals.
- Are you sure c_1, c_2 and c_3 are unitless? I could be mistaken, but I think the units of some of these may depend on the values of others. I don't recommend going into details, but maybe you could mention it (if it is indeed true) and not say that it's unitless.
- Sometimes you use round and sometimes square brackets to indicate units, both in text, tables and figures.

13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?

The explanation of the P and ET corrections could be shortened and clarified (see specific comments).

14. Are the number and quality of references appropriate?

Yes.

15. Is the amount and quality of supplementary material appropriate?

Yes.

Specific comments

28-23: You mention intense rainfall events in autumn. Is this before November (the start of the non-vegetated period)? In other words, did you take these events into account in your analysis?

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31-17 “Evapotranspiration is influenced by the seasonal cycle of the vegetation”: The seasonal cycles of temperature and radiation also have a large influence on ET.

32-2 “which renders the study more challenging”: It also renders the study more interesting, investigating if the sdsa can be used for practical (operational?) applications.

32-6 “we need discharge data that are not influenced by human activity, as Kirchner’s method assumes mass conservation.” Human influenced catchments can still be used for mass conserving studies, as long as you have quantitative information about abstraction fluxes or hydropower reservoir storage. The trouble with using catchments with reservoirs for the sdsa is that the assumption of a unique storage-discharge relation will not hold: there are many possible combinations of catchment storage and discharge because discharge depends largely on dam operations and not on catchment wetness. Of course this limitation will reduce the applicability of the method in practice.

32-13 How was discharge measured? A photo of the gauging station could be nice to get an idea of the measurement circumstances (if you like). A discharge of 200 l/s (the lowest Q in Fig. 6, multiplied with 90 km^2) can still be measured accurately at some gauging stations. Do you have any idea of the uncertainty associated with these observations? If you would be able to draw uncertainty bands around the observed discharge in Fig. 6, the reader would get an idea of how far off the model is. This is especially useful when logarithmic y-axes are used. Maybe as an estimate of discharge uncertainty, you could assume a fixed stage height measurement error and see how it propagates in the stage-discharge relation (just an idea).

32-29: How many rain gauges did you use? What was the rain gauge density?

33-11: Can you justify the assumption that potential ET is equal to actual ET?

33-28: Does the water content in the air matter for ET reduction?

34-13: Could there be other causes for the non-closure of the water balance? Is it possible that there are other terms that are not accounted for, such as groundwater flow into/out of the catchment, groundwater or surface water abstraction, etc? How certain are you of the catchment sizes you estimated? Over-/underestimation of the catchment size could of course also lead to an under-/overestimation of the specific discharge.

35-18: When reading this the first time, I was surprised that you doubted the precipitation as well. You explained the problems with ET in detail, but did not mention the problems with P until the explanation in the discussion (starting in 53-23). I may have read over it, but maybe (a summary of) this discussion could be mentioned earlier.

37-7: Is catchment #1 “accidentally right” or do you have reasons to have more confidence in this catchment than in the other catchments? What do you think causes the mismatch in #2, #3 and #4 and the match in #1?

39-9: Being able to estimate $g(Q)$ from Q observations when P and ET are zero is extra advantageous in your case, because the corrections to P and ET are multiplicative, so this analysis does not depend on the rescaling you used.

39-23 “we avoided the vegetation period for the estimation of the $g(Q)$ function”: Does this introduce a bias towards te peak? Is it reasonable to assume that the behaviour of the catchment in a very wet state is similar to the behaviour in an average or dry state? A short back-of-the-envelop calculation: in Fig. 5, the $ln(Q)$ of the lowest bin you used for the regression analysis is at about -1.5. That amounts to $\exp(-1.5)$=0.22 mm/h. If I then look at Fig. 6 or Fig. 3, that means that only a limited section of the hydrograph is used for the regression analysis. I can imagine that eliminating summer and not using the scatter in the lower discharge regime are necessary for the application of the method, but I think it is important to mention the possible consequences of this decision.

40-17: Why did you chose a quadratic function? Based on Fig. 5 I would choose a linear relation, eliminating already one parameter.

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41-11: When I read this the first time, I wondered how you determined the ranges. Of course, 10,000 can be a small number when the parameter range you choose is very large. You do mention how you got to these ranges later, but I think it's good to mention it shortly in Sec. 3.5 as well.

46-15: The scatter is large in log space, but small in linear space. Very small fluctuations at low discharges, caused by small variations in the storage-discharge relation (hysteresis?), may appear more substantial than they really are.

47-4: Just out of curiosity: I had the problem that in dry periods, the modeled storage volume was very small and $Q + ET$ exceeded S. I had to limit Q and ET to avoid negative storage. Did that happen in your catchment as well?

49-24/26: If you plot the curves with the altered parameters in a (Q,$-dQ/dt$)-plot, do you see that changing the value of c_3 leads to similar values of $-dQ/dt$ at high $-Q$, but different values of $-dQ/dt$ at low Q? The location of the line could explain why you only see a difference during low flow periods.

51-7 "not overparameterized": I'm not sure I agree completely. I suspect that the parameters are highly dependent. Did you plot response surfaces of the outcomes of the Monte Carlo simulation to investigate this? I don't think you have to show it in your paper, but you may want to inform the reader of the outcomes.

52-12 "representative of Mediterranean catchments": Is this really true? I would expect that the Ardèche is much wetter than the average Mediterranean catchment. And, as you see, the drier the catchment becomes, the more difficult it is to apply the sdsa.

52-19 "more arid": Maybe change this to "less humid". Annual rainfall of 1400 to 2100 mm is far from arid in my opinion.

56-2 "however": I think this word should be left out, as your conclusions are not in contrast with mine. In fact, they point in the same direction: the sdsa works when it's wet enough. The Hupsel Brook catchment receives about 800 mm rainfall annually and the runoff ratio is much lower than in the Ardèche.

Table 3: In 53-25 you say that “SAFRAN is known to underestimate precipitation”. Why did P at catchment #3 decrease after correction? Can you justify this correction?

Table 6: It is striking that the year-to-year variation in NSE is very large, with some very good results. For operational purposes, this can be a challenge. After a year with good results, people can come to trust the model, which then fails completely the next year.

Figure 6: I am surprised that the peaks in August are underestimated, even though the discharge (and therefore storage) in July is overestimated. Can you offer an explanation? Does this happen in more of your runs? And if so, what does this mean for practical applications? I can imagine that for water managers this is the most important peak of the year to simulate well.

Figure 7: In catchments #1, #2 and #3 the inferred precipitation is often high (up to 250 mm when the “observed” is zero. Do you know when this occurs? When Q is small and a small fluctuation in Q has a large effect on the modeled storage? And why does it not happen at #4?

You often refer to the sdsa as “the Kirchner method” (29-28, 32-2, 32-635-14, 35-17, 37-25, 35-14, 35-17, 37-25, 48-9, 52-2, 52-11, 55-21, 55-36, 56-10, 57-20 - I may have missed some). As James Kirchner is one of the authors, I think it would be more appropriate to call the method “simple dynamical systems approach”.

Technical corrections

Some sections contain many short paragraphs of only a few sentences. Perhaps sometimes paragraphs could be joined to keep the “flow” of the reader (e.g. 39-11, 38-15, 39-25). But this is a matter of taste of course.

31-4: Historical data have shown → Historical data show?

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32-3: “discharge data. The latter” → “discharge data, which”

33-7: double bracket after “(#3)”

33-8: “we also use” → “we also used”

33-10: “using Penman-Monteith formula” → “using the Penman-Monteith formula”

37-26: “in-consistency” → “inconsistency”

38-23: Is “differentiating” the appropriate term here?

42-9 run → ran

42-13: “spatial-temporal” → “spatial”. You don’t have to mention temporal variation, because the point you want to make concerns spatial variation only.

47-28 “explanation to” → “explanation of”

55-14: “9 year” → “9-year”

Table 2: You can remove “Crop coefficient” from the Table, as it’s already in the caption. You could add the periods (e.g. “Jan.-May”) belonging to each period.

Table 3: This Table is somewhat confusing. Maybe it would help to make the numbers for your final estimate of P, ET and Q (the ones you actually used in the model) bold.

Table 5: You can remove “Non-vegetation period” as it is already specified in the caption.

Table 9: You can remove “Lower/upper bound” as it is already specified in the caption.

Table 10: You can simplify this Table by moving “SAFRAN rain” to the caption, remove the words “Catchment” and move the catchment names to a column in front of the performance measures.

Figure 3: “julian days” → “Julian days”. I would actually prefer months on the x-axes, because you don’t use Julian days in the rest of the paper. The Q, ET and P are

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missing on the y-axes. You don't need to show the x-axis for the top two plots as they are the same as in the bottom plot. Could you indicate the non-vegetated period in this Figure?

Figure 5: I prefer log axes to plotting $\ln(Q)$, like you did in the other Figures, so it's easier to compare to the hydrographs (for example to see which part of the range of Q is used). You also used mm/hr instead of mm/h.

Figure 6: The right y-axis label "P (mm/h)" is missing. I would prefer a second panel with the discharge shown in linear space to see how good or bad the fit in June and July is for "real life" applications.

Good luck!
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