Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2018-219-AC5, 2018

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Hydrological functioning of West-African inland valleys explored with a critical zone model" *by* Basile Hector et al.

Basile Hector et al.

basilehector@gmail.com

Received and published: 3 August 2018

Thank you for all the comments and questions regarding to our submission to HESS: Hydrological functioning of West-African inland valleys explored with a critical zone model". Many thanks to the four reviewers who raised relevant questions that we hope to address in this final response. We will mainly gather previous replies written in the debate phase and add our suggestions for changes in the manuscript.

RV #3 1. The authors state that this is a synthetic study of an elementary catchment, however, which is based on their best knowledge and a plethora of data of the real system. In addition, the model is validated quite comprehensively. This is not consistent. In my opinion, the authors present a well-informed case study and not a synthetic

study, which needs to be made clear in the text. If [the authors] seek generalization of their results beyond their test site (and I feel that is what they suggest with the term elementary catchment) they need to find a way to make the results transferable and show this by applying their findings to inland valley across the region.

=> In the text, the two occurrences of 'synthetic' refer to a generic virtual elementary catchment comprising an inland valley (as in P3. L18: 'idealized elementary V-shaped catchment'), designed for generalization, and regardless of the "well-informed case study", which we use to draw schematic configurations to build virtual experiments, also based on our knowledge and literature review of other inland valleys configurations. From these results we draw conclusions on the sensitivity of such critical zone system to its unknown and likely-to-evolve components (vegetation, clay lens, lithology). We will remove occurrences of 'synthetic', which are misleading.

'Elementary' refers to the usual term : the smallest catchment (two hillslopes) draining into first order streams. The modeled synthetic case is built based on our knowledge of inland valleys. The model is not intended to reproduce every single inland valley behavior, but instead draw the first order lines of the impact of main inland valleys characteristics (clay lens), of their sensitivity to changes (in land cover) and to largely unknowns parameters (susbsurface lithology). We reckon that further explanations should be added to the abstract, introduction, and conclusion. We also hope that the references added on topography (see reply to reviewer #1 & #2 above), and on similar hydrological behavior from the inputs of reviewer #4 (see below) further help the understanding of the framework.

Modifications in the manuscript: Abstract. L17: replace 'synthetic' by 'virtual generic' Abstract. L.17: Model forcings are based on 20 years data from the AMMA-CATCH observation service and parameters are evaluated against multiple field data (Q, evapotranspiration –ET-, soil moisture, water table levels, and water storage) acquired on a specific elementary catchment. The hydrological model applied to the conceptual lithological/pedological model proposed in this study reproduces the main behaviors observed on a highly instrumented elementary catchment., allowing to further conduct virtual experiments:

P3. L19: replace: 'This deterministic modeling approach largely builds on the large panel of observations available within the AMMA-CATCH observation service (www.amma-catch.org (Galle et al., Submitted; Lebel et al., 2009) and several campaigns, as well as on a highly instrumented elementary catchment for which we previously built a conceptual lithological/pedological model (Hector et al., 2015).' In the first section, we briefly discuss the physical environment and how we model it using a physically-based CZ model. Then, we present the results of a reference case, which are compared to observations from an elementary headwater catchment in the hard-rock area of the Sudanian region, to show that the model is able to reproduce to a large extent the complex critical zone behavior. We finally use the results of a set a virtual experiments to infer the model sensitivity to the main inland valley features (presence of a clay layer, hydrodynamic properties of the contributive areas, vegetation distribution), and discuss these results.

by

' This idealized elementary V-shaped catchment is built based on the main features of elementary catchments comprising an inland valley in the region (slope, clay lens, vegetation distribution), but also following a highly instrumented elementary catchment for which we previously built a conceptual lithological/pedological model (Hector et al., 2015). In the first section, we briefly discuss the physical environment and how we model it over a 7-years period using a physically-based CZ model. Then, we present the results of a single simulation, which are compared to observations from an elementary headwater catchment in the hard-rock area of the Sudanian region, available within the AMMA-CATCH observation service (www.amma-catch.org (Galle et al., Submitted; Lebel et al., 2009) and several campaigns, to show that the model is able to reproduce to a large extent the complex critical zone behavior. We finally use the results of a set of virtual experiments to infer the model sensitivity to the main inland valley features

(presence of a clay layer in the valley thalweg and hydrodynamic properties of the contributive areas) and the vegetation distribution, likely to evolve, and discuss these results.

P.4 L4: ...built following the literature of the region and on inland valleys, and the...

P7. L13:Y-direction slope is 4 % and X-direction slope is 2 %, following Runge (1991) and specific values for the Nalohou catchment.

P19. L23: replace: 'In this paper, we studied the hydrological functioning of Sudanian inland valleys and their sensitivity to land cover and contributive areas through deterministic sensitivity experiments using a physically-based critical zone (CZ) model applied on a synthetic catchment which comprises an inland valley. This is a first approach to try to investigate what can control and explain the behavior of an inland valley.'

By: 'In this paper, we studied the hydrological functioning of Sudanian inland valleys and their sensitivity to land cover and their main features (pedology of contributive areas, clay lens), through deterministic sensitivity experiments using a physically-based critical zone (CZ) model applied on a virtual generic catchment which comprises an inland valley. This is a first approach to try to investigate what can control and explain the behavior of an inland valley.'

3.Define the length of the time series earlier in the text. => Done in the introduction: see modification P3. L19

4. The forcing is homogeneous over the model domain? => The meteorological forcing is indeed homogeneous over the domain. The domain extent is small enough to justify this. We will mention this precision in the text, thank you! Modifications in the manuscript: P8. L15: PFCLM is being forced at a 30 mn time step, over the 7-years period 2006-2012, with spatially homogeneous forcings.

5. Is it evaluation or validation data; please check section title => The data is evaluation

data (as in section 2.5 title): we will replace the single occurrence of ‘validation’ by evaluation because this is indeed evaluation of a synthetic case. Thanks much for pointing that out.

7. I would prefer Sudanian Savanna instead of Sudanian area. => We will replace Sudanian area by Sudanian Savanna.

8. In the EOF analyses, I assume that additional modes do not show any useful information, which I find disappointing, because I would have expected perhaps also some variance over longer time scales in storages in the 7 year time series. The annual signal is clear, which is not surprising. => Mode 2 accounts for about 8% of the total variance, and this is why we did not discuss it. However, you are right, the interanual storage variations are present in this mode, but together with some residuals at the seasonal level. As our hybrid gravity data only covers 2 years, which is limited for interanual terms comparison, and because of the low level of variance explained (there is much more signal at the seasonal level than the interanual one), we did not choose to show other modes than mode 1. We will add a line to mention the content of mode 2, as explained above. Modifications in the manuscript: P12. L4. Mode 2 accounts for about 8% of the total variance, and although we do not discuss it in the current study, one should note that interannual storage variations together with some residuals at the seasonal level are present in this mode.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2018-219, 2018.