Hydrology and Earth System Sciences Discussions

Interactive comment on "Multi-criteria assessment of the Representative Elementary Watershed approach on the Donga catchment (Benin) using a downward approach of model complexity" *by* N. Varado et al.

Anonymous Referee #4

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CONTRIBUTIONS AND AUDIENCE

What are the important contributions of this paper?

The present paper applies the Representative Elementary watershed approach and a corresponding model (REW) to study the hydrology of a catchment system in Benin, West Africa. The model is used with two different spatial resolutions, increasing the number of REWs with respect to a base case study. The model is tested on a data set on the Donga watershed, a subsystem of the Ouémé river. The data have been collected in the context of the AMMA scientific Project and include meteorological runoff

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and piezometric data.

The important contributions of the paper are twofold: firstly it constitutes an additional application and validation of a novel hydrological modeling concept, secondly it utilizes a rare and thus valuable data set in a region of the world, where very little hydrological studies have been performed.

TECHNICAL SOUNDNESS

Is the paper technically sound?

The paper is in general technically sound

Are the methods fully described?

Yes, the methods used are fully described. Where no description has been provided, there are sufficient references to relevant literature. Additional references have been suggested in this review report.

Is the mathematical development complete and accurate?

The mathematical component is kept at a minimum, but appropriate references are provided. Where these are insufficient, additional references are requested.

PRIOR PUBLICATION

Has this work, or very similar work, been published elsewhere?

No, the work is genuine and original. Previous applications about the REW approach have appeared, but the present paper explores concepts that have not been addressed in other papers on the same subject. Thus the paper contains essentially novel material.

ORGANIZATION AND STYLE

Is the paper well written and organized?

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Yes, the paper is in generally well written and organized but several sentences need substantial rephrasing. Some suggestions are given at the end of this referee report.

Are all tables and figures necessary?

Yes.

Can the paper be shortened?

No, the paper should not be shortened. In the contrary, some sentences should be added where more detailed information on the methods used is required (see suggestions).

Does the manuscript require editing/rewriting to improve the grammar and English usage?

The manuscript should be revised in terms of improving the language. It is recommended that a native speaker should assist the authors in formulating relevant sentences.

EVALUATION

Does this paper make a significant, new contribution in the area of water resources?

Yes, it is an interesting paper, that deserves publication after recommended changes have been applied. However, the paper analyzes the problem unilaterally from the perspective of soil science, emphasizing the importance of an accurate representation of the shallow subsurface and hydrodynamic behavior during infiltration. However, too little is said about potential effects on sub-REW scale variability that have not been contemplated.

This fact could for example explain that for smaller sub-catchments the simulated discharge is not captured accurately. It is important to point out that at the spatial scale of such small units different hydrological response processes come into play, that may

not be captured adequately by the model.

The inclusion of a subsurface runoff zone (as a surrogate of a perched layer) would most probably diversify the reaction time of the system and thus allow to capture response signals that are not represented by the model schematized in figure 4. Adding this layer will with high probability reduce the time lag in the system response observed in Figure 6 and evidenced out by the authors.

The issue of uncertainty in precipitation/evaporation estimation has not been addressed at all. In Section 4.5 the author talk about testing model sensitivity with respect to spatial distribution of precipitation (in contrast to using constant rain), while the error of precipitation estimation, which is most likely quite significant, has been ignored. The same is to some extend valid for evaporation estimated from data at Djougou and Parakou.

It is strongly recommended to consider this fact in the exposure, it should at least be mentioned. Errors in precipitation estimations can be around 30–50% and thus contribute to erroneous discharge prediction. Using data assimilation methods (e.g. particle filtering or ensemble Kalman filtering, see Vrugt et al, papers by Gupta etc.) with input correction on precipitation and evaporation will most likely help improving the hydrologic response of the system.

With respect to the reproduction of water table fluctuation, is has not to be forgotten that the REW model reproduces REW-average water table movements, that have to be compared cautiously with point piezometric values, especially if we are considering a shallow water table system, that is strongly influenced by heterogeneities in the subsoil. This is probably the case in the Donga basin, which seems to be underlain by a ephemeral shallow aquifer system, which does not correspond to the schematization of the groundwater in the model. A representation as a shallow, perched system may be more appropriate in this case. These details should be mentioned in the text.

RECOMMENDATION

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Publish with changes made by author.

Minor comments:

General: The use of the English language should be improved. In particular the following minor points below require urgent attention. It is strongly recommended to have a native speaker revising the formulation of some sentences.

Page 2: replace "face problems" with "answer questions"

Page 4: typo: line 5 form above: "monthly"

Page 5: "A pedologic map of the region is also available": report reference to the map.

Page 5: "It stops at the end of October" should e.g. read: "the runoff dries up at about the end of October".

Page 5: "should be stocked" should read "should be stored". Please verify.

Page 5 "It raises the question of the partition between. . ." please reformulate this sentence.

Page 5 (last line): "All these wells are used as domestic wells . . ." should e.g. read: "all these wells are used for water supply purposes. . ."

Page 5/6: "No quantification of the water extracted is available up to now" should e.g. read: "Up to date there is little to no information on the extracted water volume in the basin". Please rephrase.

Page 6, (last line): "allows the derivation of. . ." should be replaced by "yields".

Page 7: "of a characteristic and the mean velocity": I guess you mean "a spatial average velocity".

Page 7: "It is situated above a saturated zone, lying on the . . ." omit "lying".

Page 7: "Table 4 lists the various inputs. . ." reformulate: ". . . REW-average input

quantities, boundary conditions and hydrodynamic parameters".

Page 7 (last line): "null" should read "zero".

Page 7 (last line): "In order not to be influenced. . ." should read: "To exclude an influence. . ."

Page 8: "injecting" should be replaced by "using".

Page 8: Please explain the meaning of *Beerkan* method or even better, avoid the expression altogether. This seems to be soil science jargon most likely not known to large part of the hydrological audience. I presume it is an infiltration experiment. The use of this expression is not acceptable in this context.

Page 8: "A try of spatialisation. . ." should read "An attempt of spatialisation. . ."

Page 8: Please specify why you choose the mean depth of the bedrock at 8 m below river bed. Substantiate.

Page 8: What is the meaning of "top-down" evaluation? Explain or avoid.

Page 8: "The simulations were evaluated on discharge. . ." Please rephrase this sentence ex novo.

Page 8: "and to better take into account the dry season" change to and to be able to take the effects of strongly reduced runoff during the dry season more accurately into account. . .".

Page 9: "At the height of the rain season" should presumably read: "at the peak of The rain season"

Page 9: "The bad temporal distribution" should read " the rather poor temporal . . ."

Page 9: "by calibration" should read "by means of calibration".

Page 10: "was slightly deteriorated" should read "deteriorated slightly".

Page 10: "The wells are bored." what does that mean? I presume "drilled"

Page 13: Please add scientific reference on the block-kriging method used in the REW model application (Lebel). Add some explanation through a sentence or two.

Page 14: "has to be faced" should read "should be tackled"

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