Dear Editor,

Thank you very much for your positive assessment of our revised manuscript. In the latest version (see attached), we have addressed and incorporated all further points raised by the three reviewers (see below).

Best regards,

Hubert Savenije

Reviewer#1

Comment:

This new version of the paper has very much improved with respect to the first version. The text is now much more formal then before, making it more in line with what is expected from a scientific paper. Although I am still not convinced of the need for a Darwinian approach, I agree that this is an opinion paper where such ideas can be launched. Yet, what may make this paper more strong is to demonstrate for what applications our current models, lacking Darwinian theory, are not suitable. For the majority of applications, a proper calibration may do the work, and the time frame over which the model is applied is probably too short to account for changes in the system... The current examples in the paper, reflecting on a reservoir-model, are not adapted to Darwinian theory, and therefore do not serve as examples where the need expanding our models with another way of physical thinking...

Reply:

We highly appreciate the reviewer's positive assessment. In Section 4, we have added a phrase to provide the link between the "reservoir-model" and Darwinian theory by giving a reference to Nijzink et al. (2016) who monitored root zone storage evolution from time series of E and P.

Comment:

page 3, line 25: these patterns (plural)

Reply:

Corrected (p.3,l.31)

Comment:

page 6, line 14: such data are ("data" is plural)

Reply:

Corrected (p.6,l.22)

Comment:

page 6, line 15: "it is, it has" -> "they are, they have" (refers to data -> plural)

Reply:
Corrected (p.6,l.23)

Reviewer#2

Comment:

I congratulate Prof. Savenije to the revision of his opinion paper as well as to his very well-reasoned response to my assessment of his first manuscript. The author did a tremendous job in addressing my key points, particularly also with respect to better discuss the complementary merits and weaknesses of process based models and conceptual models.

Reply:
We highly appreciate the reviewer's very positive evaluation.

Comment:
Pattern formation during non-stationarity (ever flowing) environmental conditions and biota, which partly engineer the environment to build and sustain their niche are indeed cardinal challenges to both our theories and models. I particularly like the inspiring way how Prof. Savenije connects these points to the ground breaking insights of Jim Dooge (published more than 30 years ago) and his related reflections on the promise of energetic optimality. The latter might provide a key to connect and unify states based mechanistic thinking (Newtonian) and co-evolutionary (Darwinian) thinking and models. The analogy of a catchment to meta-organism is more than a well-chosen metaphor – it is a blueprint for a new model paradigm. In this respect I wonder whether a title like "Catchments as meta-organisms – a new blueprint for hydrological modelling" might not better reflect the content of this paper.

Reply:
We really like the title the reviewer suggested and changed it accordingly.

Comment:
We need indeed dynamic model structures to cope with pattern formation and evolving/changing landscape characteristics which balance necessary storage, recharge and drainage. In this respect I acknowledge that the conceptual approach of a dynamic root zone provides an interesting alternative to the use of landscape evolution models the in eco-hydrology community. In a conceptual model framework it is indeed straight forward to speculate about suitable concepts for these issues in an ad hoc manner; more importantly the value of these concepts may be empirically tested within a predictive modelling exercise. In case of success we learn in a diagnostic sense that ecosystems optimize their root zone storage to survive a drought of a certain return period. From this finding we may further postulate that this might reflect an energetic tradeoff, as the plant has to perform work to grow roots. In this respect it is interesting to

refer to the recent work of Hildebrandt et al. (2016), which provides evidence that plants minimize their energy expenditure during root water uptake. In line with the authors I think that we will not make progress towards models which may deal with emergence and non-stationary catchments, when sticking too much to the established continuums approaches (which are also empirical), as they treat soil hydraulic properties as constant, the plant phenological cycle as invariant and which neglect kinetic energy in soil water flow. In fact soil properties and phenological cycles are dynamic states of the catchment as a meta-organism and kinetic energy of soil water is maybe the key to include preferential flow into our equations. Nevertheless, we may use physically based models either to test dynamic model structures/macropore systems and a dynamic phenology in a similar ad hoc fashion within an a posteriori predictive exercise (Loritz et al. 2016). The real challenge is to improve our models such, that we can deal with emergence in a predictive a priory manner, instead of showing that this is helpful after the fact. In this context it is interesting to acknowledge that the alternative route to success can also imply a more rigid physical treatment, instead of conceptualization. A good example is the direct numerical simulation of dune formation by Kidanemariam and Uhlmann (2014), which is based the least small of assumptions. Last not least I 'd like to admit that the interesting concept of two water worlds the authors refer to is not so much out of the box, in fact it is a straightforward implication of soil physics and the soil water retention curve (Zehe and Jackisch, 2016).

Reply:
We fully agree have also largely incorporated the suggested references

Reviewer #3:
Comment:
Just a few minor editorial remarks, a suggestion to include a reference to Prof. em. Pete Eagleson's book "Ecohydrology: Darwinian Expression of Vegetation Form and Function", and a few clarification questions. See 23 comments in annotated manuscript.

Reply:
We would also like to thank reviewer #3 for his very positive assessment. We have now incorporated the suggested reference (p.4,l.2) and all comments provided by the reviewer in the annotated manuscript.