

Interactive comment on “A topographic index explaining hydrological similarity by accounting for the joint controls of runoff formation” by Ralf Loritz et al.

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Review of “A topographic index explaining hydrological similarity by accounting for the joint controls of runoff formation” by Loritz et al., 2019

The manuscript tries to introduce a new topographical index called DUNE which presumably can differentiate the runoff generation mechanisms in comparison with the other topographical indices. The paper is well structured and use of English language is good and sufficient. However the manuscript needs significant clarification and its scientific merit should be better justified. My major concerns are:

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1- Too broad and philosophical introduction, need more citation of relevant work, need more focus: I found the introduction very broad and philosophical. As a reader, I was not able to follow what message the authors would like to convey in the introduction. Introduction ends with vague sentences such as “how can the geomorphic . . .”. I am not an expert in the field of geomorphology but I assume there should be a significant body of literature on this topic. I believe the introduction benefit significantly from focusing on the existing methods for extracting information from topography, their importance and relevance to hydrological modeling and possible need for a new index (DUNE).

2- Too few catchment for the study: I am very surprised by the number of few catchments that the authors have used in this study. I suggest the authors to include more catchments with more diverse forcing data. This needs to be address for applicability of the study. If there is a reason why only a handful of catchments are selected then it should be explained.

3- Unfair comparison of the indices: I found the comparison of the topographical indices unfair. To my point of view, TWI was not intended to be used with very high resolution DEM as currently is available. The assumptions of the TWI is based on the unit length and that is the case when the changes across length is minimal. This assumptions is not valid anymore when moving to a very high resolution DEM. For example, a very dry cell can be located near a very wet cell (Figure 13-d of Gharari et al., 2011). The suggestion from Hjerdt et al., 2004 is also aligned with this the mentality of relaxing the assumption of TWI from local slope to more of a transect slope which is more representative. Moreover, TWI, HAND etc are resolution dependent this should also be addresses. I am not asking the authors to repeat the study for different resolutions but it may have some benefit mentioning this aspect in the discussion part.

4- Novelty and viability of DUNE is not justified: both HAND and DUNE and other topographical indices are valuable information on the catchment scale routing and runoff generation mechanism however the real applicability needs more justification and larger sample of headwater catchments. I am not sure if DUNE is a new concept.

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To me, DUNE is as simple as slope and in fact it is a, kind of, average slope compared to the river network. The assumption to derive the DUNE are oversimplified. For example the available energy in the catchment is not the same as HAND. It would be the case if the catchment was impervious with no soil, porous medium, and vegetation. However the state of catchment energy is less due to the negative pressure or potential energy of the unsaturated soil. This is explained by the authors in their recent work also (Zehe et al., 2019). Moreover, the authors have mentioned that the similar indices have previously been proposed. So my question is to what degree DUNE bring us closer to better estimation of the runoff regime. What is the added value? This needs to be clearly justified and embolden.

5- Correlation is not causation: Without going into too philosophical discussion here, I would say the inference of the result based on the correlation of the DUNE and its hydrological regime might not be a good estimator of the causation, in this case processes. Information theory (binning), with all its power, as used here is not really about the internal processes of the system. In this study also the authors are looking directly to the output of the system rather than the internal behavior. My questions then how the internal behavior can be differentiated using DUNE. As an example, the internal preferential pathway might be different in the two geology; does DUNE able to reflect on those differences?

6- Applicability of the DUNE for practical purposes: I totally missed how DUNE can help hydrological modeling or hydrological understanding in comparison with other topographical indices. This needs to be further clarified. For example, previous works from TU Delft group, have shown the added benefit of topography in inclusion of more hydrological knowledge (true or not that was proposed and implemented [I think it was right], Savenije 2010, Gharari et al., 2014, Gao et al., 2014). Similarly, TWI is used as a basis of the TOPMODEL. How do the authors would like to use DUNE in hydrological modeling?

7- Information content is all binning, how can information/distribution be compared with

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various bin sizes: To me information content is only about the binning of the available data into designed bins. Basically information gained by a data is to which degree we can justifiably discriminate them. Did the authors really looked into the information content here? I don't see that, so why they have discussed the bin sizes for this study? And do different bin sizes change the conclusion for the various indices?

8- Other topographical indices: as the authors rightly mentioned there are more than DUNE out there. Can the authors tell the same story using another topographical index? For example, and to what I see from the Figure 2, does the average slope or river network density have the power to make the distinction between the hydrological regime similar to median of DUNE values? Visually it seems that it has.

9- No substantial conclusion: it seems that the conclusion can be written even without looking at the manuscript. The conclusion is very general and it lack any point. I strongly would ask the authors to include bullet point conclusions that reflect the manuscript finding in a one to one fashion. One more time here, the authors have talks about the system architecture, my question how DUNE can reflect on the system architecture hypothesis. Any suggestion on that should be presented in the introduction, methodology and discussion part.

10- Literature review: Please include all the relevant work and their context in the study. A coherent story is needed instead of just mentioning a sentence from each study in isolation. Each sentence should also be discussed in its proper Section. For example and after reading the paper I was surprised that the authors have mentioned more similar work that has been done in the past. Moreover, a more comprehensive literature review on the effect of soil, topography are needed for this study and its application. As an example, author can take a look at the reference of Gharari et al., 2011, 2014, Fang et al., 2019.

Overall, I am positive that this manuscript can be an interesting contribution to the field of hydrology and hydrological modeling, however I am not convinced in the current

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format the manuscript meets the applicability and reproducibility standards. I would therefore suggest major revision for this study and I am more than happy to receive the revised version of the manuscript.

With kind regards

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