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# Reply on RC1

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Author comment on "A dynamic hierarchical Bayesian approach for forecasting vegetation condition" by Edward E. Salakpi et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2021-290-AC1, 2022

Reviewer 1

Review of: A Dynamic Hierarchical Bayesian Approach for Forecasting Vegetation Condition. This study proposed a method to forecast vegetation condition index by means of soil moisture and precipitation data in Kenya by means of Bayesian method. I find the study not very well structured and difficult to follow given lack of information on the data sources used and period of analysis. In any case the justification of the study is mostly related to the assessment of drought forecasting but I cannot find any analysis and result that can be directly focused on drought analysis. The authors should detail better and illustrate more if long-time series are used and if forecasting is useful during critical drought periods. See specific comments below. They refer to specific lines of the manuscript:

Response:

This paper is part 2 of a previous paper (https://doi.org/10.5194/nhess-2021-223) and uses the same data (reference was made to this in section 2.1.). But I realise this was the wrong decision, so a full description of the data used for this research will be added to the data section.

Secondly, the entire premise of this paper was based on our earlier paper, Barrett et al. 2020 (https://www.sciencedirect.com/science/article/pii/S003442572030256X). We aimed to improve the precision and accuracy of the VCI forecast beyond the six weeks achieved in the Barrett et al. 2020. Thus, the analysis of our results mainly focused on the accuracy and precision of the VCI forecast beyond six weeks. And more specifically, on how our proposed model differentiated VCI forecast within a given region of interest.

The research was in partnership with the NDMA. They are currently using VCI for monitoring drought. They have used the indicator extensively for their monthly drought reports and bulletins.

However, all the issues raised about the paper structure are well noted and will be addressed accordingly.

- Does this number refer to the global scale? What is the source?

Response:

Yes, this is on a global scale Source: https://wwfint.awsassets.panda.org/downloads/drought_risk__wwf_.pdf . The source of the information was not properly cited, and this will be fixed in the updated version of the paper.

- Note that enhanced atmospheric evaporative demand increases the severity of agricultural droughts, particularly under low soil moisture conditions.

Response:

We agree that atmospheric evaporative demand is vital for agricultural drought studies. Information on atmospheric evaporative demand will be included in the introduction and discussion and recommended for future work.

- But also human practices may reinforce drought severity or reduce it as a function of soil management, and crop rotation. See the several studies by Prof. Rattan Lal about this issue.

Response:

Comment accepted and well noted; information on this will also be included in the paper's literature review section.

- I would say that ecological droughts and hydrological droughts are also strongly complex. I would qualify this issue.

Response:

This is also well noted and will be included in the literature review section of the paper.

24-24. I would include issues related to crop practices, crop types, etc.

Response:

Comment well noted and accepted; issues on crop practices will be included in the introduction section of the paper.

36-88. In the introduction, I am surprised that dynamic forecasting of drought based on climate models is not considered (e.g. https://www.nature.com/articles/s41612-021-00189-4). There is a large research topic on this issue that should be mentioned/discussed in relation to the statistical techniques proposed in this article.

Response:

Comment well noted; however, the focus of this paper was using the Hierarchical Bayesian Model to provide differentiated forecasts within a given region of interest and I do not see how this links to the suggested paper. This notwithstanding, we will have a thorough look at the suggestions and see how to put them in context.

- What are the sources of precipitation, VCI and soil moisture? This must be detailed and discussed in relation to the availability of the data, quality, time period of analysis, etc. There is not sufficient information to determine which data the authors are using.

Response:

We accept that it was a wrong decision to refer the reader to data sources in a previous paper (https://doi.org/10.5194/nhess-2021-223). This will be corrected in the final draft of the paper. Please see the data sources below:

| **Data** | **Source (Producer)** |
|---|---|
| Precipitation | Climate Hazards Group InfraRed Precipitation (CHIRPS) - 2001-2018 |
| Soil Moisture | European Space Agency's Climate Change Initiative (CCI) - 2001-2018 |
| Surface Reflectances | NASA MODIS (MCD43A4 v006) - 2001-2018 |

- What are the variables that are intended to be forecasted (precipitation? Soil moisture? VCI? All of them?) This is not clear in the methodology what is the target variable and what is the usefulness of the other variables. Maybe are precipitation and soil moisture possible drivers of the VCI and they are used to generate a predictive model of VCI? This should be clarified. This is indicated below 180-220; but it should be explained in detail before to avoid confusion. I would also suggest atmospheric evaporative demand as predictor of the VCI as several studies have demonstrated strong importance on agricultural and ecological drought conditions.

Response:

The target variable is the VCI and lags of precipitation and soil moisture are being used as drivers for the VCI in this context. The comment is well noted and will be clarified as suggested.

In this paper we considered variables that could be directly derived from satellite remote sensing products. However, the suggestion of the atmospheric evaporative demand is well noted and will be recommended for future work

Figure 5. Why is only one year of results showed in this plot? I would suggest to include longer time series as we cannot determine if this year correspond to drought or to normal and humid conditions.

Response:

Unfortunately data was limited by access to readily available soil moisture data. At the time of data acquisition and preprocessing our soil moisture data was only up to 2018. HBM was calibrated to data from 2001 to 2016 and evaluated on 2017 and 2018 data which is why the model evaluation was a single year.

Figure 6. What about seasonality? Is the model capable to forecast vegetation conditions with the same accuracy for seasons of high or low vegetation activity? This should be at least discussed. What is the different performance between drought and non-drought years?

Response:

This comment is also well noted, analysis of seasonality is available and will be included in the discussion section of the paper.

Figure 7. I see not only agricultural areas are considered in the study but also forest lands so introduction should be modified to also focus on ecological droughts.

Basically all the figures are showing a single year for the VCI forecasting and it is not clear for me if this is the period of analysis or it is an arbitrary selection. In any case. This must be clarified as I do not think robust results and conclusions related to the suggested methodological approach can be obtained from the application to a single year.

Response:

This is also well noted, the definition of ecological drought will be included in the introduction section. We used a single year because the aim here was to show how well the HBM forecasted VCI for different agro-ecological zones and vegetation land covers for up to 12 weeks ahead.

- Where is this analysed? I cannot find a plot in which this relationship is showed.

Response:

These can be seen in the Percentage Relative Importance plots figures D1 and D2. These figures will be moved to the main document under the results section and discussed properly.

- A reason to include also atmospheric evaporative demand as predictor...

Response:

Well noted, It will be considered in future work as the funding phase for this project has ended.