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Comment on nhess-2021-114

Anonymous Referee #1

Referee comment on "Stochastic system dynamics modelling for climate change water scarcity assessment of a reservoir in the Italian Alps" by Stefano Terzi et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2021-114-RC1, 2021

General Comments

The manuscript aims at presenting a modeling of water storage and outflow in a reservoir in northern Italy within the framework of a stochastic approach. I found the general goal of the paper well present, and in line with the scope of the journal. The methodology is overall well organized, even if more emphasis needs to be given to the components that are modeled stochastically vs. the deterministic ones.

I found that the presentation and discussion of the main results can be significantly improved, e.g. the complete absence of any statistical tests supporting the significance of the observed changes. This is an even more glaring omission given the use of a single climate projection for the assessment of future conditions.

Additionally, given the focus on water scarcity (as from the title), I would strongly suggest to expand the analysis on extreme conditions (below the chosen 30th percentile threshold). Currently, the analysis focuses solely on the number of events below the threshold, which may lead to incorrect interpretation if not integrated by other metrics (such as event duration, severity, number of days under the threshold, or similar). I think that those additions are relatively easy to implement to the manuscript, and they will considerably improve the robustness of the conclusions drawn.

Overall, I found the paper very interesting and I suggest to the authors to account for these major drawbacks before considering the manuscript for publication.

Introduction

The SDM methodology needs to be better introduced. Section 1 fulfill this role, but in my opinion it needs to be integrated directly in the introduction instead of being a separate section.

Methodology

This section needs to clearly highlight where the stochastic component of the model plays a role. If I have understood correctly, only the modeling of the reservoir level and outflow is done in SDM, whereas the input flow is modeled with a deterministic approach. Since human activities (and climate change) may influence also the upper basin, some considerations on the assumption made may be useful for a reader. E.g. How much anthropogenic activities are in the upper basin?

Results

I found very limiting the lack of tests on the statistical significance of the differences from the baseline. This is particularly relevant since you are using just a single climate projection model.

Additionally, the analysis on the extremes (30th and 80th percentile) needs to be expanded. Limiting the analysis on the number of events may severely bias the analysis. You should integrate with the duration of such events, number of days under a threshold and the severity (in the case of drought).

It can happen that a smaller number of events in the future is due to the occurrence of less event but much longer.

Specific Comments

P2 L51-57. Here a more detailed explanation of SDM is need, with a clear description of the advantages and disadvantages of deterministic vs. stochastic approach (move and reword from Section 1).

P3 L72-73. Can you please better clarify the role of connectors and the differences from converters? (maybe using two different examples rather than the same).

P4 L94-99. This paragraph would fit better in Section 3 in my opinion. In general, Section 1 seems unnecessary, and I will move its content in either introduction (first part) or Section 3 (second part).

P5 L125. It would be nice to have these numbers contextualized in comparison to e.g. average flow.

P6 L149. Fig. 2. It is not clear to me the role of soil (type?) and land-use as vulnerability factors. Please briefly clarify in the text.

P6 L150. part of the caption in Fig. 2 seems missing.

P7 L158. Fig. 3. I understand the need to have different “baseline” period in different components. However, is there any way to homogenize those references or at least use a different name for each one of them? At the moment, when you refer to baseline in the text it is really difficult in some cases to understand to which period are you referring to.

P9 L197. Table 2. It is not 100% clear to me what are the other models reported here. Are those the best for each model type (among the ones in supplement materials)? Please clarify.

P9 L197. Table 2. Please highlight in the table the models selected as “best”.

P10 L216. Eq. (2). Is the random effect still just the month as in Eq. (1), or is it in the first term as well through V? Please clarify an eventually emphasize this key difference.

P10 L227. I'm not familiar with this procedure, but I'm assuming that you ends with 58 calibrations. which one is used at the end, or how are them combined? Please clarify.

P11 L242. Why this asymmetric choice instead of 20 and 80? This needs to be justified.

P11 L244. Which baseline period? It may worth to specify here.

P11 L247. It is not clear to me where the Monte Carlo approach is used. Is it used only for

the percentile analysis?

P11 L254. This sentence is a little confusing. I'm assuming that the storage for "flood prevention" is higher than the maximum due to the additional volume stored to prevent a potential downstream flood, but the way the sentence is presented is confusing. Please reword.

P12 L257. Figure 4. Please clarify the meaning of the dotted lines (percentiles?). Same in Fig. 5.

P12 L265. If I understand correctly, this means that the most important component (inflow) is the one that is not affected by the stochastic modeling. This needs to be further discussed and emphasized in order to clarify the value of using the stochastic approach in similar conditions.

P13 L270. In the whole section, statistical significance of the changes need to be reported. Even changes with different sign may not be that different if the changes are not statistically significant (also accounting for natural fluctuation within the 30-year window). See Welch test or similar.

P 14. Figure 6. I'm not sure that showing each single year is relevant, since these are projections. I would find a way to show time slices rather than annual/sub-annual values.

P15 L302. It would be interesting to integrate the analysis with the result in terms of contribute to the annual storage. Differences in rainy months may be much more relevant for the total storage that during the dry months, even if the percentage differences are comparable.

P16 L312. Number of events is not the only relevant metric. For drought/water scarcity: are those events longer? what about the number of deficit days per year? Is the total/average deficit of these events increasing? For flood: is the max surplus increasing? Those are examples of simple analyses that can be added without much effort.

P16 L322. You should add also the same statistics for the reference period. How those number differ from the reference values? Are the differences in the short term (2021-2050) in line with what is already observed? Is the current condition (2021) very different from the reference period? Some insights on that would be useful to understand the reliability of these projections.

P17. L340. Please check the use of the term “negatively” here (and in the rest of the discussion as well). This can be interpreted as either mathematically (sign minus) or qualitatively (to worse). I suggest to rephrase.

P18 L353-354. What about flood? Can increasing storage during winter be a problem in case of flood? Please elaborate.

P18 L356. Increasing in high and low volumes? I’m not sure that this sentence is in line with your results. Please clarify.

P18 L359. I think that the Monte Carlo results may give an idea on the robustness of such changes, but this is not discussed at all at the moment.

P18 L364-365. This is more a conclusion that a discussion of the results.

P18 L375. This is a very important point that needs to be highlighted in the methodology as well.