

## ***Interactive comment on “Hydrological impacts of climate change on small ungauged catchments-results from a GCM-RCM-hydrologic model chain” by Aynalem T. Tsegaw et al.***

### **Anonymous Referee #2**

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This study aims at assessing the impacts of climate change on flow patterns and patterns and frequency of floods in small ungauged rural catchments in Norway. It is an interesting manuscript that is mainly well prepared and structured. The study reveals that higher mean annual discharges are expected at the end of the 21st century. Mean annual floods are projected to increase compared to the baseline period. The manuscript's results contribute to the knowledge of climate change impacts in terms of river discharges in western Norway.

I have basically three concerns:

1. Only one RCM has been used that was driven by bias-corrected input of only

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one GCM. Nowadays, a state-of-the-art climate impact study should not base its results solely on one climate simulation, but on an ensemble of climate model simulations. Moreover, the results are only discussed for RCP8.5 at the end of the 21st century. In the discussion section, the authors address this issue and put their results into a larger context (Norway study), which is important, but not done in sufficient detail. Plotting precipitation and temperature projections of the NorESM1-M / WRF model in the context of the CMIP5 or CORDEX ensemble would be helpful here. However, I am not sure whether putting the results into the context of another study justifies the approach of using only one climate simulation as input.

2. The description of the hydrological model and the regionalisation approach in the Method chapter is quite long (6 pages). I think, this is not appropriate for a manuscript claiming to investigate climate impacts. In between I wondered whether the main focus of the manuscript is actually on climate impacts or on the methodology to be applied in ungauged catchments. What I would expect to read instead is something like this: "The DDD model is a lumped, conceptual hydrological model with a module simulating the slow flow component (subsurface) and the quick component (runoff dynamics)." Additionally, something about the temporal and spatial scales, it can be applied to, that it is not fully or semi-distributed...
3. Especially in the discussion and conclusion sections, the authors mention many times the novel bias correction method that has been applied. From my point of view, instead of providing a lengthy description of the hydrological model, a description of the novel bias correction method would be much more valuable in the context of a climate impact study.

**Besides these three main concerns I have made a lot of comments on the attached RC2-supplement-pdf file.**

## General comments

- The introduction is a bit lengthy, particularly the section between rows 70-87.
- English is usually adequate but some sentences are incomprehensible or poorly expressed, e.g. following sentence: "*The regional impacts of climate change (e.g. on local flooding) come out with the necessity of orienting adaptation measures to local climatic, geographic, economic and social conditions.*"
- The authors should consider having the manuscript revised by a native speaker.
- The authors use the term "hydroclimatic elements" meaning variables, such as precipitation and discharge. I recommend to call these "hydro-climatic variables" not elements.

## Technical

- Multiple citations should be ordered by year.
- Equations. Many variables in the equations are not explained or mentioned in the text, some examples: Eq.2:  $Q(t)$ ; Eq.5:  $C_{ea}$ ; Eq.6:  $M$

Following articles might be worth citing in some contexts in the manuscript.

- Blöschl, G. et al. (2019). Changing climate both increases and decreases European river floods. *Nature*
- Blöschl, G. et al (2017). Changing climate shifts timing of European floods. *Science*, 357, 588-590

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Please also note the supplement to this comment:

<https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2019-359/nhess-2019-359-RC2-supplement.pdf>

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2019-359>, 2019.

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