

Reply to Anonymous Referee #2 on the manuscript
“Contrasting dynamics of hydrological processes in the Volta River basin
under global warming”
(Manuscript hess-2021-525)
by M. Dembélé et al.

Dembele et al. (2021) evaluate uncertainty in hydrologic variables based on twelve GCMs from CMIP5 dynamically downscaled by five RCMs over the Volta River Basin in Africa. This paper is written clearly, and it is an interesting study, particularly considering the expected population doubling between 2010 and 2050 and implications, which can be associated with changes in water redistribution. I have some minor comments which I kindly ask the authors to consider during manuscript revisions.

We thank the reviewer for this very positive overall appreciation of our work and the constructive review and valuable comments. Below are our responses to each of the comments.

Some less critical analyses could possibly be moved to Supplement to ease the reading and to keep the focus on the most important results. Mainly, if a figure is explained in one sentence, it requires to be moved to Supplement, e.g. Fig.12). Possibly, the Supplement itself is also very lengthy, and I suggest, remove less important figures.

We agree with the reviewer to move Fig.12 to the supplementary material. Moreover, we will reduce the content of the supplementary material.

On the other hand, I have missed some evaluation of hydrologic model performance. I understand that was done in earlier studies, but it might be helpful to include observation-based climatology, say from ERA5, into Figure 5.

The paper is already long as the reviewer highlighted in the previous comment. Therefore, we prefer to refer the reader to the full study on model calibration where model performance is detailed.

For consistency, adding ERA5 climatology to Figure 5 would require also adding the climatology of the other reference datasets used for bias-correction (i.e. PGF v3, WFDEI, EWEMBI, MERRA-2, JRA-55 TAMSAT v3.0, CHIRPS v2.0, ARC v2.0, MSWEP v2.2, PERSIANN-CDR v1r1), which would result in a cluttered figure. We think Figure 3 already provides a good comparison of the satellite and reanalysis datasets to the RCM-GCM datasets.

By using the historical period 1991-2020, the historical and RCP simulations get mixed. Should not be the historical period be considered only prior 2005?

The historical period can be chosen beyond 2005 as done in some previous studies (e.g. Almazroui et al. 2021; Hanus et al. 2021; Mengistu et al. 2021; Abubakari et al. 2019). As said by Hawkins and Sutton (2016): “A number of factors enter the decision about an appropriate observational reference period, for example, to be representative of the most recent conditions but long enough not to be overly influenced by random fluctuations, to be a period the public can relate to...”. According to Liersch et al. (2020): “The Intergovernmental Panel on Climate Change (IPCC) will use the years 1995–2014 in its Sixth Assessment Report”. The most current and widely used reference period for climate analyses by the World Meteorological Organization (WMO) is 1981–2010. We have chosen

the period 1991-2020 to have a more recent context for understanding climate change. We will further discuss the choice of our reference period in the manuscript.

The title requires changes. Please replace mainly these two words that do not fit the current version of the paper: “dynamics” and “processes”.

The term “dynamics” is used here to refer to the temporal and spatial changes observed in the hydrological processes (i.e. rainfall, evaporation, runoff, groundwater recharge, soil moisture and terrestrial water storage) as a result of climate change. As suggested by the Anonymous reviewer #1, we will investigate the method of circular statistics to assess changes in the days of occurrence of low and high flows and their variability, which is an indicator of seasonality, to further consider the dynamics of hydrological processes (see https://www.nwrfc.noaa.gov/info/water_cycle/hydrology.cgi).

Which PET method was used in the climate projections? This study (e.g. <https://www.nature.com/articles/nature11575>) suggests that different results can be obtained for different PET methods). Could you please clarify?

We agree that different PET methods would lead to different results. In fact, we have thoroughly discussed the limitations of the choice of PET methods at lines 454-467 but we missed to mention the method we have used (i.e. Hargreaves and Samani). This will be corrected in the new version of the manuscript.

Bootstrapping should be considered for the analysis presented in Fig. 9, Fig. 13, to account for varying sample sizes between RCPs.

We understand the suggestion of bootstrapping as we do not have the same number of models for each RCP. The bootstrapping can help to randomly select a common number of RCMs to do the analysis and repeat it. However, we think it will not solve the problem, as the underlying distributions will still not be the same. One solution would be to restrict these analyses to the models for which we have the 3 RCPs available but it would restrict our analysis to only 5 RCM_GCM runs. Therefore, we prefer keeping the results as it with as many RCM_GCMs as possible. However, we will highlight the issue of varying sample sizes between RCPs in the discussion.

Textual suggestions:

lines 16-17: Rephrase abstract, the first sentence, into something like: “This study conducts a comprehensive evaluation of the impacts of climate change on the West Africa Volta River basin's water resources, as the region is expected to be hardest hit by global warming.”

Ok.

lines 22-23: Reformulate into something like: “The bias-corrected climate projections are then used as input to the mesoscale Hydrologic Model (mHM) for hydrological projections over the twenty-first century (1991-2100).”

Ok.

Lines 31-32: rephrase into: “and amplifying the local population's vulnerability.”

Ok.

line 37: “at a faster rate” => “faster”

Ok.

lines 43-44: “Climate change and anthropogenic pressures increase water resources' stress (Sood et al., 2013)”

Ok.

line 45: “for” => “to”

Ok.

line 60: rephrase into “usually focused”

Ok.

line 67: reformulate to “the repercussions”

Ok.

line 72 remove “provide knowledge to”

Ok.

line 75: maybe “central” instead of “major”

“major” is more appropriate here.

Figure 1: it would be more helpful to split the grand legend block into figure panels, where individual classes are shown.

Not sure if we understood the suggestion. However, the current figure arrangement allows saving space and avoid not having many figures only for the description of the study area.

Line 94: “the assessment of” into “assessing”

Ok.

Line 123-124: Possibly rephrase into “As the RCMs downscale not all GCMs,…”

Ok. Would be “As the RCMs do not downscale all the GCMs…”.

Line 188: “a steady-state”

Ok.

Figure 3 caption: Write clearly this is the historical period (keep consistency with the other figures)

Ok.

Figure 5 caption: should be: “... for the historical and future periods (under RCP8.5).”

Ok.

Figure 6-7 caption: synchronize legend (e.g., *_2050) with figure caption (2021-2050).

Ok.

References

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