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Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "Assessing the impact of rainfall seasonality anomalies on catchment-scale water balance components" *by* Paolo Nasta et al.

**Anonymous Referee #3**

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Review of "Assessing the impact of rainfall seasonality anomalies on catchment-scale water balance components" by Paolo Nasta et al. for HESS

The main research question of this study, as presented by the authors in Line 64, is "What is the impact of rainfall seasonality anomalies on annual-average (or seasonal-average) water supply, and what happens if the Alento River catchment (ARC) will experience several consecutive years of lower-than-expected rainfall events?" The authors use SWAT (Soil Water Assessment Tool) to assess the changes in the different catchment water fluxes in response to changes in rainfall seasonality, using ARC as a study site. The changes in rainfall seasonality is simulated through two different approaches: (i) a "static" approach based on the SPI (Standard Precipitaiton Index) and (ii) a "dynamic" approach by decomposing seasonality into a magnitude, timing, and



duration components following Feng et al. 2013. While simulating the changes in rainfall seasonality via a Monte-Carlo approach, the length of the seasons are set across multiple years but varied across the 3 case scenarios ("reference," "dry," and "wet") for the "static" approach, whereas for the "dynamic" approach, the duration of the wet season in each year is randomly drawn from a normal distribution (line 220 – 222).

To me, the set of main questions is at once too broad ("the effect of rainfall seasonality on the annual catchment water yield") and too specific (effects on one catchment, ARC). The presentation is overall loose and acutely needs focusing. By this I mean that it's not clear to me what conclusions to be drawn from this study other than "by changing rainfall seasonality under scenario X, we simulated a reduction in water yield at this Mediterranean catchment by Y amount," which does not give much scientific insights into how this particular Mediterranean catchment might function (in response to the second part of the main question), nor how the results may be able to be generalized to other Mediterranean catchments around the world (in response to the first part of the main question). Perhaps this is just an issue of having to refine the main question a little more. At one point the authors also state "the goal of this study is to characterize the rainfall seasonality and its anomalies by using two approaches (Line 84)" – to what end? Not only do I find this goal to be a little aimless, but it's also not clear to me how this would help advance the overall research question stated earlier. I understand that this relates to the methodology through which the main questions were interrogated, but why two different approaches? And what did the authors learn from adopting the two different approaches?

The authors claim that the questions of how the catchment water balance plays out in Mediterranean question remains largely unaddressed ("As far as we are aware, there is still a lack of knowledge about the effects of possible changes in rainfall seasonality on the water balance of a catchment subject to a Mediterranean climate, and the analyses presented in this paper aims primarily at contributing to fill this gap." (Lines 84 – 86)) I find this statement to be surprising and again, vague and unrefined, since there is

already a large body of work that already attempts to address this question in one fashion or another, via theoretical and empirical approaches, that remains uncited:

- Potter et al. 2005 “Effects of rainfall seasonality and soil moisture capacity on mean annual water balance for Australian catchments” WRR.

- Hickel and Zhang 2006. “Estimating the impact of rainfall seasonality on mean annual water balance using a top-down approach” JoH.

- Viola et al. 2008 “Transient soil-moisture dynamics and climate change in Mediterranean ecosystems” WRR.

- Gentine et al. 2012 “Interdependence of climate, soil, and vegetation as constrained by the Budyko curve.” GRL

- Andersen et al. 2012 “Assessing regional evapotranspiration and water balance across a Mediterranean montane climate gradient.” AFM

- Williams et al. 2012 “Climate and vegetation controls on the surface water balance: Synthesis of evapotranspiration measured across a global network of flux towers” WRR

- Feng et al. 2015 “Stochastic soil water balance under seasonal climates” PRSA

- Viola et al. 2019 “Impacts of hydrological changes on annual runoff distribution in seasonally dry basins” WRM

The authors do not make an attempt to contextualize the results of their work against a larger set of studies on water balance in seasonal and Mediterranean climates, and I find this disappointing. My goal in listing these references is not to encourage the authors to simply cite them, but also to use them (amongst others that I have certainly missed) as a starting point to actually pinpoint where the existing knowledge gaps are, and articulate clearly how, using the current approach, they are able to fill them. For example, the fact that we need to account for climate seasonality and non-stationarity when considering annual water balances, to me, does NOT constitute a knowledge



gap – this has been the conclusion of many previous papers.

Other comments:

Line 47: “The amount of rainfall in each season can be suitably decomposed and simulated considering the following three main components.” It’s not clear to me how this statement fits in with the rest of the introduction. Why is intra-annual variability discussed at this point, when the focus of the study is on inter-annual variability of seasonality? I suggest the authors move this into the method section when discussing the Monte Carlo simulations for daily rainfall. Also, the representation of rainfall via a stochastic Poisson process (which this set of criteria is describing) should be associated with more foundational studies than those of Van Loon et al. 2014 and Feng et al. 2013 – this was introduced first by Rodriguez-Iturbe et al. 1987 “Some models for rainfall based on stochastic point processes” in PRSA and more widely disseminated in Rodriguez-Iturbe et al. 1999, PRSA.

The presentation of Budyko’s curve as a conceptual and unifying framework is commendable, but it that it is too rushed. This may be a widely used concept in hydrological sciences, but it does not make a first appearance until the results section (starting on line 367!!) and need to be motivated better in the introduction and methods section.

Additionally, description for each of the “static” scenarios (“reference” “dry” and “wet”) also only makes first appearance in the results section (lines 265-270) and need to be moved to the methods section.

SWAT model calibration has not been adequately described. While the performance is shown to be good at the monthly scale (line 141), there could still be compensating model parameters. It would be helpful to see a table of calibrated values for the list of model parameters in lines 137 – 141.

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