Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2020-236-RC2, 2020

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Characteristics of droughts in Argentina's Core Crop Region" *by* Leandro Carlos Sgroi et al.

Anonymous Referee #2

Received and published: 21 October 2020

The authors' present an interesting manuscript which discuss and deal with a climatology of different drought properties such as magnitude, frequency at different time scales, duration, and severity in central Argentina. Drought conditions along 40 years of rainfall and soil moisture records and the related standardized indices (SPI and SSI) are analysed. They conclude that most droughts tend to occur for periods shorter than three months, but a few can extend up to one year and fewer even longer while in the the core crop region, corn yield is the most sensitive crop to dry conditions. The topic of the paper fit well in HESS and is of regional interest to HESS readers. While the work and findings are interesting, there are some issues that need to be clarified.

General comments.

While I understand what the authors are trying to do, as it stands now, the manuscript

appears to be a collection of statistical analyses related in some way to drought issues, but no clear objective or story is followed. In particular, what is the main goal of the paper? Is it aimed at developing a monitoring system, to provide information on the link between the indicators and crop yield or just provide a climatology? It seems that the research is focused on the main 3 crops but at the end only a qualitative comparison with yields is shown. I recommend to focus and tailor the discussion in one aspect, in particular, the link with crop yields (see some comments below).

Abstract: The abstract could be improved, it should be rewritten focussing on the main goals of the manuscript and trying to avoid general statements like: "It is of interest to assess the relationship between those properties and the crop yields." Or "As relevant as the drought duration is its timing and severity".

Introduction: In the last two paragraphs of the intro it would be better to focus on the goals of this paper and how this advances the knowledge in this specific subject. Details on drought indicators should be explained in the methods section.

Methods section: the description of yield data is somehow misplaced and cuts the logical flow of the description of the meteorological variables. Consider placing it at the end of the section after the description of the standardized indicators.

I'm curious to know why this methodology was selected (eqs. 1 and 2). Does this approach perform better than a parametric approach? I guess that the length of the records (40 years) shouldn't be a problem to fit a parametric distribution. Please motivate this decision and provide a more critical discussion on the methodologies adopted, including advantages and possible shortcomings.

Section 2.3: This is a key section that needs to be strengthened. The drought definition (in the first paragraph) is quite general and vague and it is not clear how this is implemented in the following description. Please be explicit here, e.g. "in our framework a drought starts when our drought indicators are below 1 sd and last until it reaches (threshold) again. . . ". Moreover, it seems that only one month with negative values of

the indicators defines a drought. This is not the most accurate definition of droughts, which need some time to become established, in particular with the threshold chosen (-0.5). However there are some cases where droughts can develop quickly, e.g. flash droughts and lead to large impacts, but not sure this is reflected here. Please, again, motivate clearly your drought definition. This is key to follow the results.

The use of precipitation anomalies is not the best approach to make a regional assessment. How do you compute those? I guess P-P*. This procedure could give misleading results, as the anomalies are not comparable between regions or even different months/seasons. Let's suppose you have one locality with observed 50 mm in one month where the monthly mean is 100 mm, then the anomaly is -50 mm, then for another locality you have observed 5 mm but the monthly mean is 55mm, here your anomalies are again -50 mm. How these deficits are comparable? How do you include those in the areal average? If the goal is to capture the high frequency variations a more suitable indicator would be the percent of Normal precipitation or the SPI-1. Please, for further discussion on that matter refer to the WMO-GWP handbook of drought indicators and indices and references in there.

Section 3.1.1. There is an issue with the results in this section, probably due to the lack of drought definition (particularly Figs 2 and 3). The authors compute the probability of occurrence over standardised indicators which means that the probability to be below -1 sd should be 0.1587 if these indicators follow a perfect normal distribution. I'm afraid that this is what is shown here with the spatial variability due to some statistical instability. Here a more meaningful series of maps could be the return period of droughts or even the number of drought events per pixel.

Section 3.1.3. Same issue here as in section 3.1.1. Maybe I'm missing something important here, but what is the added value of showing a histogram for a set of standardised variables?. Even if these represent a regional average, each single point should follow a normal distribution with mean=0 and sd=1, any deviations from this means some problems with the fitting or the input variables (marked dry season, many

zeros, etc.). Please clarify, adapt your description towards potential problems in the fitting or add additional relevant information.

Section 3.2: There are many studies that relates climate variables and droughts to losses on crop yields in the region (Holzman et al 2014; Podesta et al. 2009; Scian and Bouza 2005; Seiler et al 2007 to cite but a few). This section presents a qualitative description of negative impacts of droughts on crops. Please, clarify how these results advance the literature on the topic in the region or how they are relevant in the context of this study. I believe that the data presented are valuable and could help to answer some questions proposed here, such as what indicator is most appropriate to predict crop losses. For example, a correlation analysis/ contingency table, etc. between the different indicators (and specific dates sensitive to the crops) and the crop losses would make this section much more relevant. This could support some affirmations like the ones on lines 396-402. At the moment the highly sensitive months are presented a-priori.

The affirmation that corn crop is the most sensitive to water deficits is due to the fact that it is the crop with higher yield/ha (more than 2x to than the other according to lines 323-324). Relative losses related to their average yield values would make their values comparable or even could be greater for the other two crops. As you mention lately corn is also highly sensitive to heat waves as well. Compound events could intensify these losses, but this is not discussed here.

Particular comments

Line 17: "However, if a multiyear drought experienced breaks, each period would be considered a separate case" this is not clear, please consider rephrasing or even removing this from the abstract.

Lines 19-20: "Even short dry spells may have large impacts if they occur at the time of the critical growth period of a given crop" this is not discussed or demonstrated in the manuscript. Please, if this is a general statement, consider removing it from the

abstract or perform more analysis that can support this affirmation.

Lines 21-22: This also seems a general and rather speculative statement. Consider removing it from this section or perform more analysis that can support this affirmation (see my comment for section 3.2).

Lines 122-126: The performance of a model in the representation of soil moisture is not trivial. Here, there is no mention on how the GLDAS performs in the region. A formal validation is not necessary but at least some references describing its validity in the region are needed. See for instance, Spennemann et al., 2015 & 2020.

Line 47: This only apply to dry events; wet events has a completely different dynamic. Please, clarify.

Line 69: Agriculture will be only one sector affected. Droughts can affect almost any compartment of economy and ecosystems.

Line 104: the sentence between [. . .] should be removed of placed elsewhere.

Line 203-205: how the soil moisture can be affected by soil degradation and desertification? Is this modelled in GLDAS?

Line 207: The SPI-6 could be correlated with hydrological droughts (probably longer aggregation periods can do it better) but it is still a meteorological indicator as relies only on precipitation. It is not accurate to attribute the representation of hydrological droughts to it. Please consider rephrasing this sentence.

Line 216-217: How the maps in Fig 3 can be interpreted as the temporal evolution of drought frequency?

Lines 314-315: "Therefore, droughts in the Core Crop Region are detected more easily when using SSI instead of SPI." It is not possible to benchmark drought detection by just comparing two drought indicators. Just because one indicator covers more area or is more severe, etc doesn't mean that is the best performing indicator. Instead, I

would argue that the best indicator should be the one that better represents the specific sectorial impacts, in this case, crop production.

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