

Referee 2

This paper deals with the topic of defining a new combined drought indicator (CDI) capable to anticipate crop drought events. To do so, authors combined a meteorological indicator (SPI), a soil moisture indicator (SMAI) and a vegetation indicator (NDVIA). Authors established four levels of alerts with the corresponding actions and assessed this new indicator comparing monthly alerts with crop damage provided by the agricultural insurance. The research carried out in this paper is of interest, and I think it is adequate to NHESS journal. The manuscript is in general well-structured and the results that follows seems very reasonable to me. Correlation between the proposed CDI and crop damage is correctly presented. It seems to me that the manuscript could be published as long as the authors answer the following comments:

We greatly appreciate the positive evaluation of our study.

Specific comments: 1. Authors are using a different definition of the levels of damage crop in the abstract and in the results or conclusions. Are the levels “watch, alert, warning type I and II” (see abstract) or “watch, warning to alert (type I and II) (see conclusions)? Regarding Table 3 it seems to be “watch, warning, alert type I and alert type II”. In effect, there was a mistake in the abstract. Table 3 and rest of the text is the correct version, with watch, warning, alert type I and II.

2. Could the authors extend the definition of SPI in “Methods”? Some explanation of how SPI is calculated should be included to improve general understanding.

This has been included: "*SPI is calculated by fitting the precipitation data to a gamma distribution, after which it is transformed into a normal distribution. The SPI values can then be interpreted as being the number of standard deviations by which the anomaly observed deviates from the long-term mean.*"

3. Could the authors explain how SMAI is calculated in the studied areas?. Did the authors obtain in-situ measurements?. How did you obtain the temporal evolution of SMAI in the studied areas?

This was done purely through modelling of the soil moisture in the soil profile. We explained this on page 5, in section 2.3, but it appears that our explanation was not clear enough. We have rewritten this part so that it is clearer to the reader. "*The deviation of the soil moisture from its long-term mean was expressed as a Soil Moisture Anomaly Index (SMAI). SMAI values were calculated for each of the five selected agricultural regions, similar to the SPI. To obtain this index, we first calculated soil moisture dynamics through the simple water balance model of Brocca et al. (2008). The long-term mean soil moisture was taken as the 10-year mean in the study period (2003-2013)....*" A full description of this water balance model and how it was parameterized is given on the next lines.

4. Regarding your sentence: "Figure 3 shows the variation of SMAI over the studied period and for each of the five studied agricultural regions. The main two dry periods of 2004-2005 and 2011-2012 are not consistently apparent." Do the authors think that the information given by the calculated SMAI increase the accuracy of the drought prediction?.

We believe, as stated in the cited sentence, that the impact of SMAI is not as clear as that of rainfall and vegetation stress, expressed through SMAI. Its effect appears to be clear for some pixels, but not for all of them consistently. This is in contrast with the hypothesis that precipitation deficit leads to a soil moisture deficit which, in turn, leads to vegetation stress. The reason for this is that soil moisture response to droughts is highly non-linear making prediction difficult. In other words, since the soil acts as a buffering reservoir, it complicates the response of the prediction model, and sometimes a precipitation deficit does not lead directly to a lack of soil moisture

However, as we state in the introduction, we believe it is critical to consider more than just precipitation for drought prediction. We think it is important to include soil in drought models, even though prediction becomes more complex. Another drawback is that our capacity to model soil moisture is limited on these regional scales. Future studies could focus on the use of soil moisture sensors to improve predictions.

5. NDVIA in four pixels have been calculated for every region. Could authors explain how these pixels have been combined to obtain the NDVIA per region?. Is simply the average of the four NDVIA values?

Yes, the average was taken. We added to the end of section 2.4. "*For each of the five regions, the final NDVIA index was then calculated based on the average of the four points or pixels of that region.*"

6. The proposed CDI seems to be a modification of Sepulcro 2012 indicator. I think some comparison with the latter, at least some advantages and drawbacks, should be included in the discussion. Is CDI the name of a family of combined indicators or is specifically the name of one indicator?. Perhaps, to avoid misunderstandings, the name of the new proposed CDI should be modified to distinguish it from the Sepulcro's CDI.

Our indicator is indeed a modification of the Sepulcre-Cantó 2012 indicator, designed to be able to work at a finer resolution. See the discussion on this in the introduction, page 1 lines 19-20 "*For the management of local policy and mitigation actions, such as farm-scale insurance schemes, smaller spatial scales than those used by Sepulcre-Cantó et al. (2012) are required.*"

We had already included this comparison between Sepulcre-Cantó's CDI and our new CDI in the discussion : from p.10 line 30 till page 11, line 4. We also discuss other indicators in this section.

With respect to changing the name, we strongly believe CDI to be adequate. While there might indeed be some initial confusion, we think that once the reader becomes absorbed in the text and methodologies, it is obvious where the

differences lie. We do not believe combined drought indicator" should be a trademark name, but it could refer to any index using different (Sub)indices. Or, if you like, one could interpret our indicator as being similar to the Sepulcre-Cantó one, but simply differing in the way some variables are calculated although basically taking into account the same 3 variables: precipitation deficit, soil moisture deficit and plant stress.

Technical comments:

We thank referee 2 for these technical comments, they have greatly helped to improve the text and all have been taken into account

1. Pag. 1 – line 21/22: Review format references in the text. An example: (e.g. Wilhite 2000).

corrected

2. Pag. 2 – line 21: I suppose you are referring to a fig. 1 of another article. Clarify this please.

We found it difficult to clarify and have deleted this reference.

3. Pag. 4 – line 9: Replace “o” by “or” and “y” by “and”.

corrected

4. Pag. 4 – line 29: What is the meaning of SPI-SL 6?

It refers to the name of the programme code. We do not exactly know why the developers have chosen this name.

To clarify this, we have put this between " " and rephrased it as follows " *The programme "SPI_SL_6.EXE", ...* "

5. Pag. 5 – line 2: Replace “o” by “or” and “y” by “and”.

corrected

6. Pag. 6 – line 27: “This study proposes a CDI that combines three combines..” I suppose you want to say “three indices”.

corrected

7. Pag. 7 – line 9: What is Agroseguro?. Explain please.

added, " *...the provider responsible for Spanish agricultural insurance schemes.* "

More information can be found here:

<https://agroseguro.es/agroseguro/quienes-somos/introduccion-y-objetivos/introduction-and-objectives>

Agricultural insurance in Spain is based on joint participation between public and private institutions. It is voluntary, and the private insurance companies participate via a co-insurance pooling scheme. Agricultural insurance cost for producers is partly subsidized by the Government.

8. Pag. 8 – line 5: Indicate fig. 4 is an example of the year 2004.

added.

9. Pag. 8 – line 23: Indicate fig. 6 shows a monthly evolution.

added.

10. Pag 10 – line 27 – 29: Move to Introduction. Authors should explain this Sepulcro 2012 indicator in the introduction.

We already discussed Sepulcre-Cantó's paper in the introduction, but we have now expanded this section in order to explain it better. We believe it is appropriate to repeat the reference to their work both in the introduction and the discussion.

p.2, lines 18-22: " *The above-mentioned methods can be used to evaluate the impact of drought on agricultural productivity in regions world-wide as Sepulcre-Cantó et al. (2012) have shown for Europe. These authors proposed a combined drought indicator using SPI, fAPAR and soil moisture calculated from a regional hydrological model. For the management of local policy and mitigation actions, such as farm-scale insurance schemes, smaller spatial scales than those used by Sepulcre-Cantó et al. (2012) are required.* "

11. Pag. 17 – Figure 3: In the first graph (3a) replace SPI-3 by SMAI.

corrected