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Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "A coupled human-natural system to assess the operational value of weather and climate services for irrigated agriculture" *by* Yu Li et al.

**Yu Li et al.**

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We thank the reviewer for the positive comments and thorough review that will surely help us improving the manuscript. We will take all of them into consideration while revising the paper. Below, our point-to-point response.

Referee comment n.1

The subject of the paper "A coupled human-natural system to assess the operational value of weather and climate services for irrigated agriculture" is of direct interest to the Journal of Hydrology and Earth System Sciences. Authors introduce and apply a



framework in the context of measuring the operational value of weather and climate services (WCs). The validation of the usefulness of the WCs to the final users is a much needed step towards the realization of these services.

SPECIFIC COMMENTS

1. One of my concerns is the limited duration of the analysis period (2001-2005). Why authors didn't extend the analysis beyond 2005. Is it due to the limited data availability? If yes, it would be also interesting to see similar results for a longer time period even for less forecast products.

   The motivation for limiting the analysis to the time period (2001-2005) is manifold: 1) the historical observations available for running the model covers the period (1993-2005), which were divided into two periods with the first period used for post-processing the forecast products and the second one for performing the analysis; 2) ECMWF forecast products are obtained from the ENSEMBLES project, which provides hindcasts over the period (1960-2005); 3) CSF v2 and CanSIps cover the period (1981-2010), but they are outperformed by ECMWF products. We will clarify this point in the discussion of limitations/assumptions of the study that we will include in the conclusion section (see point 3 below).

2. Assuming that instead a single forecast product, a large ensemble developed by the combination of several products could outperform the forecast quality or the result to better decisions compared to single products?

   We agree with the reviewer that a larger ensemble (note that all the products we used are in the form of ensemble forecast) might attain a better performance in terms of forecast quality and, possibly, also in terms of operational value. However, the use of multi-model ensembles opens up a number of challenges - such as how to limit the smoothing effect on the extreme events, how to combine multiple products with different levels of accuracy, how to simplify the uptake of the resulting large ensemble - which goes beyond the scope of this paper and can be

explored in a future analysis. In the revised version of the paper, we will include this point in the list of limitations/assumptions added to the conclusions section, suggesting the opportunity of exploring it in a future research.

3. Another subject that could also be discussed is the limitations and/or assumptions of the study. I think that a limitations section should be added in the paper in order to summarize the main simplifications or assumptions considered in the work. For example the determinant yield factor is the water availability no matter the agricultural treating of the farmers during the cultivation period. Maybe such a section could also include some references to works in which they have been treated in other way.

   The point raised by the reviewer is well taken. In this work, we didn't explore the impacts of agricultural practices (primarily the use of nutrients and fertilizers) as the water availability is predominant in the considered case study. The validity of this assumption is discussed in our previous work (Giuliani et al., 2016). However, we agree that other determinants factors can be explored in a future work. Following the reviewer suggestion, we will include a list of limitations/assumptions of the study in the conclusion section of the revised manuscript. This list will include the limited duration of the analysis (see point 1), the limited exploration of the socio-economic dimension of the problem (i.e. the prediction of crops' prices which are instead assumed as deterministic in the current analysis), the assumption that crop yield determined by water availability is the main driver of the cropping pattern decisions.

   *Giuliani, M., Li, Y., Castelletti, A., and Gandolfi, C.: A coupled human-natural systems analysis of irrigated agriculture under changing climate, Water Resources Research, 52, 6928–6947, doi:10.1002/2016WR019363, 2016.*

Considering these and the fact that the scientific significance and quality are excellent, my suggestion to the editors would be to accept after minor revision in the context of



my specific and technical comments. I am listing a number of suggestions in the form of technical comments that will improve the presentation of the study.

We thank the referee for the positive comment and for his/her thorough review of the paper which will contribute in improving the presentation of the study.

TECHNICAL COMMENTS

- P4 – Study site section: since you are dealing with end-user services it would be nice if you include more information, a short description of the users (total number of farmers, average farm extent, etc.). Following the reviewer suggestion, in the revised version we will include additional information on the case study and the users (e.g., the Muzza irrigation district is characterized by a hierarchical structure, which includes 39 irrigation units at the first level, which can be further partitioned in 1722 "comizi" at the second level).
- P4 – L9: Here you mention 40% for maize while in Fig. 1 shows 74%. We thank the reviewer for noticing this discrepancy, which is due to a typo in the text, while the legend is correct. We will fix it in the revised version of the paper.
- P5 – L2: you could also say that climate change has exacerbated the severity of the extreme events (drought/heat wave). We agree with the reviewer suggestion and we will modify this sentence accordingly.
- P5 – L5: what about 2001? Judging from Fig. 4 2001 was even drier than 2003 and 2005 (also in Fig. 6 for the April to August precipitation). This figure is probably not able to fully characterize the variability across the considered year. In fact the reviewer is correct in saying that 2001 seems drier than 2003 and 2005. However, in 2001 there were abundant precipitations in winter which allowed storing water in the form of snow and in the Lake Como, thus ensuring adequate irrigation during the agricultural season. Conversely, 2003 and 2005 had also a dry winter, thus facing the most critical conditions for the agricultural activities in the

basin. Following also another comment on this figure, in the revised manuscript we will add information about the total annual precipitation and average temperature to allow distinguishing the conditions in 2001 with respect to the ones in 2003 and 2005.

- P5 – L26: add cross reference for Table 1. Following the reviewer suggestion, we will add a cross-reference to the table in the revised manuscript.

- P9 – L5: Why do you set the resolution to 250m? Is this resolution adequate for representing the spatial detail of the crops/properties? The resolution of the model was set in previous works (e.g., Vassena el al., 2012) to allow a proper characterization of the spatial distributions of all the components of the model, especially in terms of water balance module. *Vassena et al. (2012), Modeling water resources of a highly irrigated alluvial plain (Italy): calibrating soil and groundwater models, Hydrogeology journal, 20(3): 449-467.*

- P9 – L25: Does this model take into account the behavioral dependency on the preceding year? Meaning that the farmers' decision is affected for example from a "previous (i-1) dry year" and as a result the potentially optimistic decision of year i would be more pessimistic? In principle, our model can account for this type of behavioral dependency. However, the calibration of a decision model implementing such behavioral dependency requires long behavioral time series to identify the proper lag-time as well as the magnitude of the effect for different levels of drought intensity. In the absence of such large observational dataset, we decided to partially explore this point by 1) simulating farmers' decisions made assuming the next year is equal to the previous one or to the average of the last two (see EmpPast and Emp2Ave experiments); 2) running a sensitivity analysis using different levels of risk aversion. In the revised version of the paper, we will include this point in the list of limitations added to the conclusions section, suggesting the opportunity of exploring it in a future research where enough observational data



can be available.

- P12 – Table1: the products listed here are single member experiments or there is a number of realizations? All the forecast products are in the form of ensembles: ECMWF products have 9 ensemble members (or 3 in case of decadal products), CanSIps have 10 ensemble members, CSFv2 has 4 ensemble members. We will include this information in the revised table 1.

- P13 – Figure 4: You could also add total precipitation and average temperature for each year (row) on the right part of the figure (on the left from the legend). We thank the reviewer for this useful suggestion (which also allow solving the other issue of Figure 4). In the revised version of the paper, we will add information about the total annual precipitation and average temperature.

- P15 – Figure 6: it would be easier to read if you place the legend of each product on the corresponding sub- plot. Otherwise you could arrange the legend in similar order as the subplots because it is hard to detect. It would be also helpful if you could highlight the dry years. Following the reviewer suggestion (shared also by R2), in the revised version we will move the legends inside the subplots as suggested to improve the interpretability of the figure.

  16 – Figure 7: The differences are hard to distinguish. You could plot the anomalies instead or adjust the range of the temperature axis (for example from 17 to 23oC). Again it would be also helpful if you could highlight the dry years. We agree with the reviewer and, following his/her suggestion we will improve the readability of the figure by adjusting the range of the temperature axis and by moving the legends inside the subplots.

- P18 – Figure 8: You could use a continuous line for the deterministic simulation. We thank the reviewer for the suggestion and, in the revised version of the paper, we will modify the figure accordingly.

*P23 – Line 32: remove the space from "f armers"* We will fix the typo in the revised version.

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