

## ***Interactive comment on “Benchmark levels for the consumptive water footprint of crop production for different environmental conditions: a case study for winter wheat in China” by L. Zhuo et al.***

**Anonymous Referee #1**

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The study presents an attempt to estimate benchmark levels for the consumptive water footprint of winter wheat in China by applying the crop model AquaCrop. Water footprints simulated for the period 1961-2008 are compared between dry and wet years, between warm and cold years, across soil types and between irrigated and rainfed wheat. Such an analysis is interesting in general and fits also well to the scope of the journal. However, I think that the manuscript requires substantial improvement before it may be considered for publication in HESS. My main points of criticism are:

1.) I completely miss a discussion on the relevance of the water footprints obtained in the present study. Why is this information needed? Farmers, for example, are not interested in optimizing water footprints; they are more interested in optimizing

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their economic return. The attempt to optimize the water footprint to benchmark levels provided in this study may also be misleading from an environmental or ecological perspective because these water footprints can only be achieved when nutrients are not limiting, thus require high nutrient inputs and consequently high nutrient losses. Currently, over-fertilization is another burning environmental problem in many cropping regions of China. Finally, from a hydrological perspective, it also sounds not logical to minimize the water footprint in humid regions (e.g. in Southern China) where water does not limit wheat yields and where water scarcity is not a problem for the society nor the environment. What I'm questioning here is the one dimensional focus on water productivity in the current study which makes it impossible to draw useful conclusions from the results.

2.) The authors use a crop model to calculate water footprints but they completely miss to describe the model, its parametrization and its calibration. Therefore the results are not reproducible by external scientists. For example, the authors compare water footprints for warm and cold years. Temperature affects many different processes and to interpret the results of the study it is essential to know which effects have been considered in the model used here. How much is the difference in simulated evapotranspiration between cold and warm years and are the changes mainly an effect of different temperature or of associated differences in other variables, e.g. radiation or humidity? How is the effect of different temperature on crop yields? In general, higher temperature results in faster crop development and shortening of the period between sowing and maturity and therefore, in most cases, in lower yield. However, this effect can only be reflected in the model when the harvest date is considered dynamic. As far as I know AquaCrop offers two options: simulation with fix sowing and harvest dates and simulation with fix temperature sums. The shortening of the growing period can only be simulated when the second option is used. Therefore, description of the model parameterization and associated assumptions is essential. Furthermore, there is no information whether the model was calibrated, for which target variables the calibration was performed and which parameters were adjusted in the calibration process.

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3.) The target variable for the study is the consumptive water footprint which requires simulation of evapotranspiration and crop yield. Previous research (e.g. all these recent model inter-comparison studies) indicated a high uncertainty in present model results for both variables. Since only one specific crop model has been used for the present study it is a challenge to prove the reliability of the results, in particular when considering that the reported differences shown between cold and warm years, irrigated and rainfed wheat, humid and arid regions are relatively low (Tables 2-6). How did the authors validate their results? The comparison of simulated yield to yields simulated with a another model (Figure 8) and the comparison of province level yields reported for one specific year with potential yield simulated by the authors provide little evidence that spatial patterns and temporal dynamics in water footprints simulated for this study are reliable. Therefore, the section describing the model validation needs to be extended and improved.

Specific comments: - Which process explains differences in the water footprint across soil classes for the irrigated winter wheat? If drought is the only stress factor considered in the study, the soil class should not have an effect for the irrigated winter wheat. - Tables 2-6: Do you really show averages in the last column or is it the median (50th percentile)?

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