

## ***Interactive comment on “An improved method for calculating regional crop water footprint based on hydrological process analysis” by Xiao-Bo Luan et al.***

### **Anonymous Referee #1**

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In this manuscript the authors enhance the Water Footprint method to a regional scale. For that purpose, the water losses in the irrigation water distribution system are included into the WF (blue water). A procedure for the quantification of water losses in the canal system is introduced. The topic addressed in this manuscript is relevant and has certain novelty for the water footprint assessment. Nevertheless, several minor and major aspects need to be improved. The overall calculation approach needs to be checked, since some calculation steps are contradictory to the common water footprint method. The grammar is very poor throughout the whole paper and has to be improved.

C1

General comments: Water loss from the canal system and application on the fields is calculated as water consumption. This is not correct, because leached water recharges the local groundwater aquifers and, thus, contributes to the water availability. In that term, it is not consumed. Therefore, water consumption equals the actual evapotranspiration (for the agricultural production), while water losses (leaching from the fields) is subtracted from the water used for the irrigation. Therefore, I do not understand why you calculate it as water footprint. I can understand if you state that water is recharged in another aquifer, however the groundwater aquifers are connected. Please consider that issue with the water losses and the spatial aspect of water losses. The second scenario is not plausible, because, as stated later on in this paper, 75% of the water input comes from the irrigation, that is why this is not a red-fed agriculture and stopping all irrigation will lead to a total yield loss. Therefore, this scenario cannot exist in reality. If you want to develop a scenario, please consider, for example, deficit irrigation. Nevertheless, I do not see the necessity of the second scenario for your paper. The methodology for calculating WF on the field level (so, for the rain-fed agriculture) already exists and is broadly applied. Therefore, there is no novelty in your approach concerning that aspect. Furthermore, the results of the second scenario are missing in the section Results. Regarding the term ET, it would be good to distinguish between the potential and actual ET. I would appreciate if you specify it in the text. I would appreciate if you also address the importance of efficiency of the water distribution systems in the Discussion Please improve the grammar throughout the whole paper. Your sentences are sometimes built in a strange way and are difficult to understand. I recommend to ask a native speaker to review the paper.

Specific comments and technical corrections: L21: effectively managing -> effectively manage. L22: It is not correct to state that WF is a new method; it is used in the scientific community since decades. I would recommend deleting this statement. Abstract: please address that you are quantifying the WF in terms of blue and green water, because there are other methods, for example impact assessment using the AWARE, WSI and WAVE models, but also the grey water footprint. L26: do you mean with the

C2

term “underground water”? Groundwater use? Please use another term. L34: further -> further away. L44: to ensuring -> to ensure. L54: utilization of crop production -> for crop production. L57: What do you mean with “reduce the negative impact of the reduction of available agricultural water”? Please check and correct this sentence. L58: Globally -> globally. L62: Please address and explain here the terms green, blue and grey water instead of the term “types of resources”. L72: This data is not necessarily provided by USDA, it is available in other sources. Of course, you used this data source for your case study, but here it is better to delete the reference to the USDA. L76: Please indicate, that the WF is calculated per kg or ton of crop. L68-81 – please insert the equations for the calculation of green and blue WF. L80 – Please explain the terms net irrigation water and the actual irrigation water requirement. L89: I agree that the existing methods do not consider the water losses in canals, but the water leached from the fields (if I correctly understand the term “drainage water”) is actually considered. Therefore, please revise this statement. L95: The term “irrigation quota” is not clear. Do you mean the irrigation demand? Please add the definition and probably also use another term throughout the whole paper. L96: I would not define it as incorrect, rather not complete. L97: that is not true, precipitation and irrigation water are distinguished, that is why it is possible to distinguish between the green and blue water. The irrigation water is calculated as the amount of water to meet the part of the crop water requirement, which cannot be fulfilled by the precipitation. Concerning the groundwater, you are correct: surface water and groundwater are evaluated together for the blue water calculation. L99-101: it is not clear how it is different from the other limitations you mentioned above. L106-107 – this a repetition. L109 – 115 – the sentences are too long and difficult to understand. Please rewrite this section. L121-122: Since it has monsoon climate, the annual average values for precipitation and ET do not provide any valuable data. Consider providing average values for the dry season and monsoon season. Fig 1: Please use another word for the areas (Dengkou etc), e.g. districts in the legend, because the term “country” is misleading. L125: Could you please explain more the differences between canals and ditches? L170-172: I do not

C3

see a benefit of writing the formulas 2, 3 and 4 into the text. I recommend deleting them. L175-176: The explanation of the R2 is not needed, since it is a very common parameter in statistics. L166-189: This section includes information on the uncertainty analysis, which is a bit confusing. It distracts the reader from the actual content of the paper. It will be better to put this data into the supplementary material and only mention that the results are satisfactory. L203: What exactly do you mean with the term “irrigation water in the fields”? Surface water from the irrigation channels? Please use another term, otherwise it is not clear what you mean. L205: I do not understand how this scenario should work in reality. If the fields are irrigated, this means, that there is not enough precipitation to meet the crop water requirement. That would mean that in your scenario 2 the crops do not have enough water. So, do you also consider the yield loss? Because you cannot get the same yield under such different conditions. Equations 5-9 – please check the formatting. Eq.5 – this equation is obvious, you can describe it in the text (total WF is the sum of the green and blue WF), but you don't need an equation for that. Eq. 6- please provide more explanation. It is not clear why the groundwater, which raises to the soil plow layer, is included into the green WF calculation. Eq.7:  $Q_d$  – same as for the water loss in the canal – this is not a loss because the water recharges the GW aquifer, so actually the equation should be  $Q_f - Q_d$ . Again, including  $Q_g$  into the water consumption is not clear. Fig4 – please include explanation of Acronyms and indices into the name of the table. Could you also show the part A and part B on the figure? Eq. 10-15 – check formatting of the numeration of the equations. It is difficult to follow the equations. It would help to understand, if you split them into calculation for the part A and part B and include the explanations of the indices directly after each equation. More description of the whole calculation path is needed to follow the calculation procedure. L253: Do you mean “sections”? L255:  $Q_n$  is the actual amount. ... L270: I do not understand for which parameters these rates are. Precipitation, irrigation on field and canal loss? L290: Since you didn't consider the groundwater irrigation, please indicate here, that the blue WF includes only the surface water irrigation. L299-300: I do not see this correlation in your results.

C4

Actually, there is rather more field discharge by larger ET, if I understand your figures correctly. Please check this data. It is also interesting whether there are same irrigation techniques applied on the whole study area. Because water loss on the field depends on the irrigation method applied. Please address this aspect. L302: This sentence is a repetition, please delete. L322-325 and L310-311: These statements are obvious, because these three crops have different crop water requirement. Please consider deleting these sentences. L345: Do you mean “water footprints on the regional scale and field scale”? L346: Method for. L350-353: I understand what you want to say, but this sentence is misleading, because you firstly states, that the studies are on national, regional etc scale, but then says that the studies are on the field scale. Please change the rephrase to make it more understandable. L350-362: There is too much text explaining the methods. I recommend deleting L353-360 or insert them into the introduction and refer to it here. L366-370 –This text is not needed, please delete it. Generally, I do not see the necessity of the section 4.1. It better fits for the introduction. Fig10: I did not find any reference to this figure in the text. L379: What do you mean with applicable conditions? L383: what do you mean by stating that the rain-fed agriculture depends on groundwater? If it is rain-fed, it is not irrigated. Thus, groundwater is not used. If you mean the moisture, which is stored in the soil and used by the plants, it is the green water and not the blue water. Please revise this sentence. L429-433: You state that the method you developed also applies for the rain-fed agriculture. This is correct, because then you just exclude the irrigation parameter from the SWAT model. Nevertheless, this is a commonly used method and I do not see any novelty of your method here. For this reason, I recommend to delete this section. L456-457: You already stated in the L45, that blue water has the largest part of the total WF. Please delete this sentence.

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