List of Responses and Main Paper Changes

Dear Editor and Reviewers,

Thank you very much for your constructive comments on our manuscript entitled "Assessing water footprint of wheat production in China using a crop-model-coupled-statistics approach" (Ms. No. hess-2013-548). We have made a major revision of the manuscript taking into account all the comments and responded to the issues raised. We hope that the revisions in the manuscript and our accompanying responses will be sufficient to make our manuscript suitable for further review.

Best wishes and yours sincerely,

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Responses to the comments from editor and reviewers:

The comments of editor and reviewers are in Helvetica font, while our responses are in Times New Roman font.

Responses to the comments from editor：

1. As the reviewer pointed out, this study collected a large bulk of data to assess the water footprint. It is not the new thing in term of methodology, not even in term of data itself (because the data is not 'created' by the authors). But it is the new thing in term of water footprint assessment using new dataset especially for China (an important agricultural country), which adds some valuable information to the literature. Also, the referees' comments and authors' comments raised some opposite opinions about concept of water

footprint and the procedure for data processing (e.g., spatial interpolation). Regarding this, I would like to decide a major revision and afterward will solicit more referees to review the manuscript.

Response: We are very grateful to you for giving us the opportunity to revise this manuscript. We also appreciate your objective and cautious manner toward academic debate. We have made a major revision of the manuscript taking into account all the comments and responded to the issues raised. The issues such concept of water footprint and the procedure for data processing are modified and explained in the revised manuscript according to reviewer's comments.

2. I think the authors should pay enough attention to all the referees' comments during revision. I would also like to highlight the following issues for the authors' reference:
1) The title of manuscript should be carefully revised to reflect precisely the content of the study;
2) Clarify the methodology to calculate water footprint, and clearly distinguish the concept adopted in the manuscript from the existing ones. Highlight the rationality of your concept and procedure;
3) More deep discussions on the results are necessary, e.g., comparison to the literature values and implications for practical water resources management;
4) Improve the English significantly. Please also pay attention to the language like spelling and grammar in the future comments.

Response: The title was changed to "Assessing blue-green water utilization in wheat production of China from the perspectives of water footprint and total water use".

2) Based on distinguishing the concept adopted in the manuscript from the existing studies and reviewer's comments, we accepted the suggestion of reviewer #1 and adopted the terms "water footprint" and "total water use" in the revised manuscript.

3) More deep discussions on the results were conducted in **section 4.3.1.**

4) We have revised the whole manuscript carefully and tried to avoid any grammar or syntax error. In addition, we have asked several colleagues who are skilled authors of English language papers to check the English. We will also pay attention to the language like spelling and grammar in the future comments.

Point to point responses to the Anonymous Referee #1：

#1. The title of the paper “using crop-model-coupled-statistics” is not proper to the content of the paper. It gives the impression that you have done some advanced statistical analysis. In fact what you have done is to model the crop water use using CROPWAT and support your calculation with data from the regional administration bureau. Re-move the “coupled-statistics approach” sentence from the title. It also appears in the abstract and other sections.

Response: Many thanks for your professional comment. We re-moved the “coupled-statistics approach” sentence from the title and revised the corresponding place in the text. The title was changed to “Assessing blue-green water utilization in wheat production of China from the perspectives of water footprint and total water use”.

#2. I think you have missed the proper meaning of the water footprint by including the conveyance water loss in the estimate. Water lost in conveyance includes deep percolation to soil layers underneath the canals, evaporation from the water surface, runoff the drain, and overtopping the bunds. All this water is not lost in its proper sense except the water evaporated from the water surface. Most of the water lost in the conveyance remain in the catchment. What you try apply is the classical definition of irrigation efficiency that ignores the value of return flows, i.e. irrigation water runoff and seepage that re-enters the water supply system (Keller and Keller 1995; Perry, 2007; Seckler et al. 2003). When the return flow is reused, the overall efficiency increases. Thus, while the individual systems could have a low level of efficiency (“lost water”), the actual basin-wide efficiencies can be much higher. Therefore, taking the conveyance loss into account in the WF estimate is wrong.

Response: We revised the concept of water footprint in this paper and removed the “lost water” (percolation) from the WF.

#3. Your blue WF estimates should be the one on the field level without the conveyance loss. That means all the blue WF estimate need to be revised. The equations in the methodology section also need to be revised to reflect this change.

Response: The blue WF estimate was revised. The equations in the methodology section also were revised to reflect this change (**L147-173**).

#4. What is your general conclusion regarding the water productivity of rainfed vs irrigated agriculture? What is your advice to policy makers? In many part you have stated increased irrigation will raise yield. Is this the only solution? What about in the rainfed areas? You stated ": : :the assessment improves upon earlier research : : :" (line 4 in the abstract). It is good you have used local data to improve the estimate. However, your final result doesn't show that much of a difference to the other studies. For example your field level estimate (table 3) of 67% green is very close to the one by Mekonnen and Hoekstra (2010) who have estimated the green component as 64%. Your WF values in absolute term are not neither different to the other studies. What do you really improve upon the earlier research beside using local data?

Response: More deep discussions on the results were conducted in section 4.3.1, and questions above are answered in **P9**, **Line 332-368**.

#6. Page 558, line 8-9: the statement ": : :should have contributed more, : : :" is in conflict with your statement on page 574, line 15-17 where you stated the climate condition is not favourable for wheat in this regions.

Response: The statement "should have contributed more" has been removed in last sentence of the ABSTRACT (not Page 558, line 8-9 in hessd-11-555-2014).

#7. Page 558, line 3-5: your statement that the blue WF per unit of production reflect irrigation efficiency quite wrong. WF accounts the actual water consumption so it doesn't show the level of irrigation efficiency.

Response: The statement "and irrigation efficiency" has been removed in the revised manuscript (**P2, L51-53**).

#8. Page 558, line 18: Gerbens et al. (2009) is not a proper reference in this context. In any case I couldn't either find it in the reference list.

Response: The "Gerbens et al. (2009) and" has been deleted in the text.

#10. Page 559, line 12: Replace "quantization" with "estimation or calculation"

Response: It was replaced with "estimation" (**P2, L82**).

#11. Page 566, line 19: Replace "contrastively" with "comparatively"

Response: It was changed to "comparatively" (**P6, L226**).

#12. Page 566, line 22: Replace "accumulatively" with "together"

Response: It was replaced with "together" (**P6, L228**).

#13. Page 567, line 9: the word "withdrawal" in the sentence ": : : blue water withdrawals .." need to be replaced with "footprint". This is due to the confusion you have from the beginning – water footprint (actual consumption) is not the same as withdrawals!!

Response: The "withdrawal" was replaced with "footprint" (**P7, L237**).

#14. Page 567, line 23-25: the values are direct copy of the blue WF from line 9-11 in the above paragraph. Revise the numbers to reflect the total WF in the irrigated field.

Response: All of the values were revised in **P7**, **L259-260.**

#15. Page 572, line 23: Replace "reaping" by "producing"

Response: It was replaced with "producing" (**P10**, **L400**).

#16. Page 572, line 23-25: the sentence "Irrigation not only promotes crop yield but also increases WF of China's : : :" seems to imply that larger WF to be positive aspect of irrigation.

Please reword the sentence.

Response: The connotation of water footprint was revised and sentence has been changed to "Irrigation promotes crop yield and reduce water footprint for per kg product while increases total water use for China's wheat production" (**P9, L400; P10, L401-402**).

#17. As the discussion in page 573 and 574 shows, the interpretation of your index (QW) is not straight forward or it has little meaning without other relevant information. For example for Category I countries, the value of QW indicate irrigation can increase water productivity so it suggest expand irrigation and production in those regions. However, the regions are not favourable to wheat production as you also stated. It would be interesting to see how the result of the QW and its interpretation changes when you exclude the conveyance loss from the blue WF estimate.

Response: Good suggestion. Other indexes (QW and QF) were raised in this section in **Eq. (19), (20)** and **Fig. 7**.

#18. Section 5: the 2nd and 3rd paragraphs are discussion rather than conclusion so please change the heading to "Discussion and conclusion".

Response: The heading of section 4 is "Results and discussion" and most of sentences in section is conclusion. The sentences in regard to discussion in section 5 have been detected.

#19. Page 576, line 14: you claimed that your result is more accurate. What do you mean by that? Have you tested your result against actual crop water use (CWU) values measured in the region and tested the difference using statistical significance? I can't find any discussion or test to show how accurately you modelled the CWU and WF in the different regions.

Table 1. It would be better if you sort the table within the sub-region based on the magnitude of the WF or the province. Currently there is no logic in the arrangement.

Figure 7. It is difficult to differentiate the two lines in black-white print. Change the symbol or

the line type for one of the parameters.

Response: 1) We have tested our result against actual field crop evapotranspiration (ET) values measured in the region and discussed the reasons of difference in the revised manuscript (**L323-359; Table 3**).

2) We have sorted the table within the sub-region based on the magnitude of the WF (**Table 1** and **2**)

3) The symbol was changed (**Fig. 7**).

Point to point responses to the Anonymous Referee #2：

1. About the data. This paper uses 442 typical irrigation districts to present all the irrigated wheat for 30 provinces. How to treat other irrigated wheat beside these irrigation districts and how to determine the location of other irrigated wheat and rain-fed wheat? The location is necessary when the weather data is used. In addition, how the weather data is used? By spatial interpolation?

Response: We stated the method (weighted average) to process the weather data and explain the reason in the revised manuscript (**L360-365**).

2. About the water footprint definition. This paper assumes that the irrigated wheat grows with no water stress then defines green water footprint and blue water footprint. For the green water footprint, the potential evapotranspiration (ET) is used to compare with effective precipitation. This assumption not acceptable because only the actual water consumption is valuable in the study on water footprint.

Response: As we replied in "AC C299" in the Interactive Discussion, there is no assumption here.

3. About the result of green water footprint. According to the method in this paper, the green water footprint is controlled by potential ET and effective precipitation, so the green water

footprint should be similar. Why they are so different in Figure 5? For example, in the southwest, the green water footprint is so larger.

Response: As we explained in "AC C299" in the Interactive Discussion, water footprint for per unit product in Figure 5 is decided by water resource consumption and crop yield.

4. English need to be improved a lot.

Response: We have revised the whole manuscript carefully and tried to avoid any grammar or syntax error. In addition, we have asked several colleagues who are skilled authors of English language papers to check the English. We will also pay attention to the language like spelling and grammar in the future comments.

5. Title. "water footprint of wheat" is better than "water footprint of wheat production". "crop-model-coupled-statistics" is not reflected in the manuscript. The CROPWAT8.0 is only used to calculate ET0, so no crop model is used actually. "coupled" has no corresponding too.

Response: The title was changed to "Assessing blue-green water utilization in wheat production of China from the perspectives of water footprint and total water use".

6.P563, Line 17-19, "While the re-used or vegetation consumed part is generally small and should not influence our research findings greatly due to the deep underground water level in most areas of China." Actually, the groundwater is usual shallow in most irrigation district, so the exchange between surface water and groundwater is so strong that it can not be ignored. So the method to estimate blue water footprint is not unbelievable.

Response: We revised the concept of water footprint in this paper and removed the "lost water" (percolation) from the blue water footprint. The estimation method of blue water footprint was also revised in **L147-173**.