

Interactive comment on “Marginal cost curves for water footprint reduction in irrigated agriculture: guiding a cost-effective reduction of crop water consumption to a benchmark or permit level” by Abebe D. Chukalla et al.

Anonymous Referee #1

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The manuscript presents the first attempt to derive MCC for WF reduction. This way the authors add the cost dimension to the water footprint assessment that has not been done before. This is a very timely study and could be interesting for wider audience. The paper needs further revision before it got accepted. The introduction and the discussion section need to further expanded. Please look my detailed comments below:

The introduction section is very limited. The authors argue that the MCC has not been used in the WF study (Line 474-475) but they fail to carry out a a good literature

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review of the existing literature in the MCC in irrigation water and energy use in irrigated agriculture. I suggest to include some more literature review on the MCC analyses in general and the application of the MCC in irrigation water in particular. There are a number of studies that have been carried out to assess the MC of irrigation water eg. Gonzalez-Alvarez et al. (2006); Samarawickrema and Kulshreshtha (1999). This way, you will put your study in perspective.

line 250: you are leaving out the major component of the irrigation curve. This is especially very relevant in those water scarce regions where water is pumped from deep groundwater or from far away places (Knutson et al., 1977)! I expect this will change the whole analysis of your MCC. This will further brings up what is the water source, how deep is the groundwater, how far is the surface water, what energy is required to pump the water? The question is then if you include the energy required to bring the water to the field, how will your conclusion change? Do you think, the relative cost saving will warrant the relative yield loss?

Pareto optimal state that an allocation is optimal if an action makes someone better off and putting no one worse off. Its weakness is that it doesn't clearly tell which of the Pareto optimal outcomes is best. Besides, it doesn't require equitable use of the water. If that is the case, won't you think it is against one of the pillar of water management "Equitable share" suggested by Hoekstra (2013). Please clearly define the concept clearly and comment on it usefulness to the current study. You might think of using other term.

Even in irrigated fields, the contribution of the rainwater (green water) is very significant. To measure the contribution of irrigation to the water use efficiency (water productivity), Bos (1980) suggest the following equations (Howell, 2001):

$$WUE_i = (Y_i - Y_r) / I$$

$$WUE_{et} = (Y_i - Y_r) / (ET_i - ET_r)$$

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where WUE_i and WUE_{et} are the contribution of irrigation water to the water use efficiency (WUE) in terms of applied irrigation and actual evapotranspiration, respectively. Y_i and Y_r , the crop yield under irrigated and rainfed condition, respectively; ET_i and ET_r , the actual evapotranspiration from irrigated crops and rainfed crops, respectively.

You can define your WF as inverse of the above equations and test it if provides a better insight. At least provide a good argument for choosing to use the WF as in Eqn (3).

The manuscript could benefit by further discussion of the result, the limitations and recommendations for future improvement or further development and application of the MCC in the WF assessment.

Minor comments:

Line 59 McCraw and Motes missing year

line 68: add "to" to read "... relation to WF reduction..."

line 69; add "the" to read "... the need to enhance ..."

#line 303: please insert "used is" for "not is used"

#line 461: please delete "the" from "... to meet a given the local WF permit."

References:

Bos, M.G.: Irrigation efficiencies at crop production level, International Commission on Irrigation and Drainage, Bulletin Vol.29 No.2 pp.18-25, 1980.

Gonzalez-Alvarez, Y., Keeler, A.G. and Mullen, J.D. (2006) Farm-level irrigation and the marginal cost of water use: Evidence from Georgia, Journal of Environmental Management 80: 311–317.

Howell, T. A. 2001. Enhancing Water Use Efficiency in Irrigated Agriculture, Agron. J. 93:281-289. doi:10.2134/agronj2001.932281x

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Samarawickrema, A. and Kulshreshtha, S., "Marginal Value of Irrigation Water Use in the South Saskatchewan River Basin, Canada" (2009). Great Plains Research: A Journal of Natural and Social Sciences. Paper 999. <http://digitalcommons.unl.edu/greatplainsresearch/999>

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