Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-213-AC3, 2019


Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "Estimating water flux and evaporation losses using stable isotopes of soil water from irrigated agricultural crops in tropical humid regions" *by* Amani Mahindawansha et al.

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Received and published: 27 September 2019

Dear Matthias Beyer,

We would like to thank you for the valuable feedback provided for our manuscript entitled, "Estimating water flux and evaporation losses using stable isotopes of soil water from irrigated agricultural crops in tropical humid regions". Your comments were very helpful to improve the manuscript. Please find our point-by-point responses (starting with a '#') to the comments below.

We believe that the modifications based on the referees' comments have resulted in an



improved manuscript and hope that it is now suitable for consideration for publication as a research paper in Hydrology and Earth System Sciences.

We look forward to hearing from you.

Best regards, On behalf of the authors, Amani Mahindawansha

Interactive comment on "Estimating water flux and evaporation losses using stable isotopes of soil water from irrigated agricultural crops in tropical humid regions" by Amani Mahindawansha et al. Matthias Beyer (Referee) matthias.beyer@bgr.de Received and published: 20 July 2019 In their manuscript 'Estimating water flux and evaporation losses using stable isotopes of soil water from irrigated agricultural crops in tropical humid regions' (hess-2019-213), Mahindawansha et al. investigate the effect of different crop rotations (wet rice/dry rice/maize) in seasonally flooded/ irrigated rice fields. The authors quantified the fraction of soil water evaporation in irrigated agricultural fields while also taking into account the effect of crop species and various growing stages using the Craig-Gordon model. The topic of the study is interesting and timely but, in brief, I have mixed feelings on the manuscript. While it is clearly visible that the collected dataset can be valuable for addressing the objectives of the study, there are several points that need to be addressed in order to make this contribution really valuable for the reader. First, I have the feeling that the manuscript is lacking some internal review before publishing. The grammar is partially very poor, and I feel that several aspects (e.g. clear statement of the objectives and focus on those in the results/discussion section) should have clarified before submission. I started correcting/improving the grammar, but gave up fast on it because it became clear that major efforts are needed which I as reviewer cannot provide.

# As proposed, we will carry out an internal review again and work on the English language. A native proofreader had already checked the initial manuscript, and we were slightly puzzled when reading that the version submitted was still flawed. Nevertheless, we will send the paper again for proofreading.

Second, the combined effect of Transpiration and Evaporation should be much better addressed throughout the manuscript. Recent studies proved that transpiration is generally a much greater flux compared to Evaporation, and in a study like the presented those two need to be looked at conjunctively. In that regard, also the title is confusing, because when reading 'estimation of water fluxes', one would actually expect a water balance for the different systems, but effectively the only flux quantified is evaporation. In addition, I was confused multiple times because I was not sure if the authors speak about evaporation or evapotranspiration? (see later comments).

# We agree that transpiration is larger than evaporation and that for a water balance analysis. However, in our work, we look at evaporation as an unproductive loss term of the water balance. We will revise the title accordingly ('Investigating unproductive water losses from irrigated agricultural crops in the humid tropics through analyses of stable isotopes of water'). Hence, we have only investigated soil evaporation and the water losses from the soil due to the evaporation process. In the revised version, we will correct the wording and terminology carefully to make the distinction of evaporation and evapotranspiration always very clear for the reader.

Also, I was wondering multiple times if the authors really refer to soil evaporation when speaking of wet rice? If the field is flooded, it would be more open water evaporation?

# Yes, we agree that in a temporarily flooded field the evaporation occurs from the open ponded water body during the time of flooding. During ponding, infiltration modifies the soil water isotopic composition in the uppermost part of the profile and re-evaporation of infiltrated water has been interpreted and termed as soil evaporation. We will make the distinction between open water infiltration during ponding and soil evaporation clear.

Having that said, I cannot recommend publishing this manuscript as is. Though the topic and study are interesting and have great potential, this is often not fully explored. With more precisely stated objectives and a subsequent focus on addressing those, I encourage the authors to improve the manuscript and increase the quality and impact



of the publication. I wish the authors good luck with the revision of the manuscript.

# The revised version of the manuscript will focus on unproductive evaporation losses. We will work on consistent use of the terminology, state our objective clearly and streamline the discussion towards it. After this revision, we hope the significance and novelty of our study can be conveyed.

Down below, further detailed comments can be found. The authors state: 'None of the studies conducted so far have quantified the fraction of soil water evaporation in irrigated agricultural fields while also taking into account the effect of crop species and various growing stages. Does it make sense to calculate the evaporation from soils for wet rice, which is cultivated in a flooded system (as the authors state) → evaporation would be from open water surface anyways Suggested objective: study the effect of crop species and various growing stages on evaporation in rotation systems

# Please see our reply to the terminology of soil evaporation vs. evaporation from open water bodies, which we will make clearer in the revised version of the manuscript. Further, we followed the suggestion and specified our objectives. 1) Title: why first singular (flux) and then plural (losses)?

# We revised the title to 'Investigating unproductive water losses from irrigated agricultural crops in the humid tropics through analyses of stable isotopes of water'

2) The abstract needs to be improved. There are many sloppy formulations and bad grammar. The results section of the abstract should be underpinned with numbers.

# We revised the abstract and added numbers to the results section.

3) What are the implications of this study and how does it help to improve management or our understanding of such systems? How to compare an irrigated/flooded rice field with a field under natural conditions in terms of water isotope interpretations?

# We thank the reviewer to make these points and we added the following section to the discussion with regard to the first part of the comment. "Water losses via soil evap-

oration is a major unproductive loss term of the water budget, especially during early growing stages. To improve water management, a more detailed understanding of water cycles of rice-based cropping systems is required. Apart from reducing leaching losses, the second most important water-saving measure in these systems is reducing soil evaporation. Therefore, our study helps to increase understanding of soil water transport processes and evaporation losses from soil in response to crop rotation systems. Farmers should apply mitigation methods to reduce soil water evaporation. e.g. by mulching, or growing plant cover crops in the fallow period."

With regard to the second question: We compared flooded and non-flooded fields. In this sense, the dry rice and maize fields are representing natural conditions.

4) While reading the introduction, I wonder if the authors solely mean soil evaporation when they use the wording "evaporation" or if they actually mean "Evapotranspiration" (sometimes, evaporation is used for ET). The authors state that they are interested in studying soil evaporation, but can you look at one (E) without the other (T) in a combined system?

# The terminology for evaporation and evapotranspiration were carefully checked and addressed avoiding the confusions. Our work is focusing on unproductive water losses as explained above. Hence, transpiration is not part of this study. We additionally added the following sentence into the discussion to make it clearer. "With isotope methods, we only estimated unproductive evaporation losses from soil, because transpiration does not change the isotopic signal as it is known as a non-fractionating process (Zimmermann U. et al., 1967). Therefore, a different tool was used to estimate evapotranspiration. We rigorously tested our results and checked their plausibility by reviewing regional data reported in the literature, and by using the CROPWAT modeling approach."

5) Methods - Extraction at 200 degrees Celsius. . .good, because very clay-rich. . .but. . .was organic contamination checked? (upper soil layers and plants)



# Isotopic composition data of all water source types were checked for spectral interferences using the Spectral Contamination Identifier (LWIA-SCI) post-processing software (Los Gatos Research Inc.). None of the soil water samples was contaminated. This will be explained in the revised version of the paper in more detail.

6) Craig and Gordon modeling part should be written more concise.

# We will revise section 2.4 and present the Craig-Gordon model in a more concise way.

7) What is the difference between the isotopic signal of the soil and the original isotopic signal of soil water? (do the authors mean the 'initial signal after rain/irrigation?). How justified are the assumptions made (and those are many)?

# The original water signal refers to the initial isotopic composition of input sources to the soil water. During the wet season, larger precipitation events replenish the soil water store. During the dry season, irrigation is the main water input method due to small and rare precipitation events. Therefore, we took the amount-weighted mean values of precipitation for the wet season and or irrigation water for the dry season as initial signals. We edited the sentence as follows to make it clear. "The original isotopic signal, $\delta$p, is the initial water added to the soil (input water). During the WS, $\delta$p was estimated as the weighted average isotopic signal from most frequent large precipitation events, and as the weighted mean of the irrigation water during the DS."

8) For the results, it would be interesting to see if the fraction calculation fits with the modelled results

# Our approach offers the advantage of identifying unproductive evaporation from open water or soil, the water balance model provides data on potential evaporation and actual evaporation calculated from soil moisture constraints. These methods are complementary as they provide different fractions of the water balance. Still, as the soil water balance method does not provide information on the amount of unproductive losses,

respective fractionation cannot be calculated.

9) P1.l. 13 advance better: improve

# Edited as recommended

10) P1.l.18: progressed through the growth – bad grammar

# Corrected.

11) P1.l.23 compared to over

# Edited as recommended

12) P2 l.6-11: not only in recent years, this has been studied since Allison et al. in the 80's. . .has not been studied as much compared to what?

# We will delete the last sentence in this section, as it does not provide any further insight.

13) p.2.l.13 it p.2.l.20-32: this is well-written!

# Thank you!!!

14) p.3.l.5: Our objectives during this study are the objectives of this study are

# Edited as recommended.

15) p.3. l. 5-8: Objectives should be formulated clear and concise

# We followed the reviewer suggestion and improved the way of presenting the objectives.

16) p.3. l. 21: constancy consistency

# Corrected as recommended.

17) p.3. l. 20-23: if the mung bean plot was not used it is not necessary to mention it here



# This sentence has been deleted. We will include a note in the figure caption of Fig. 1 why mung bean plots are depicted in the figure.

18) p.4. l. 6: the model controls?...grammar

# Corrected.

19) p.4. l. 8: mixing from macropore flow from cracks?...grammar

# Corrected.

20) p.6. l. 25/26: the shape of the isotopic profiles in the shallow soil water changed depending on the crop and growth stage. → only because of that or also other factors – irrigation water isotope values, precipitation, radiation?

# We agree that this statement was incomplete and hence deleted it. In the revised version of the manuscript, we will streamline the paper according to the main objectives.

21) What are the conclusions of the authors regarding the magnitudes of evaporation? (Are these numbers given as fraction of total evapotranspiration?)

# Yes, the fractions of evaporation are given as percentages. The magnitude of evaporation is higher at the beginning of the growing period and decreases towards the end of the season. We revised the section accordingly and explain this in more detail and discuss our results in relation to other published values.

22) Fig. 3: bad resolution

# We already submitted high-resolution graphs separately in the first submission, but obviously, they have not been included in the PDF. We hope it will work out this time.

23) Section 4.3.: the statements here are very interesting and it is appreciable that the authors introduce this discussion. unfortunately they question parts of the isotopic data presented in the study

# We found this observation is interesting of formation of different hydrogen compounds under continuous inundation conditions. We think that the limits and constraints of the method need to be raised and discussed. This effect does not question the study in general as it affects only a limited set of samples. However, we just want to make the reader aware of this issue and we think this has to be considered in future experiments.

24) Conclusion: - throughout the manuscript, the phrase 'redistribution via plants/roots/etc. appears frequently', but it is not discussed anywhere. I suggest leaving this out or providing further evidence. - 'the conclusion that isotopic profiles develop via diffusion processes in the shallow soil and are then transported by advection in the matrix or in macropores or cracks' → please rephrase, poor grammar

# We will include a new section on this process in the discussion. It will read: "Hydraulic redistribution of water in the vadose zone is an important process of passive transport of soil water along a hydraulic gradient through the rooting system (Richards and Caldwell, 1987). It influences the pore water stable isotopic composition and can reshape the soil water isotopic profile especially in the shallow soil. Sprenger et al. (2016) discussed the significance of hydraulic redistribution for the hydrological process. However, the influence of hydraulic redistribution on the isotopic composition is small (Walter, 2010). In addition, isotopic measurements alone are not sufficient to estimate redistribution volumes (Emerman and Dawson, 1996)." Apart from that, we will revise the grammar in the conclusions.

25) p.13., l. 13: Do the authors really mean Evapotranspiration or rather Transpiration?

# We mean transpiration fraction of the evapotranspiration and we corrected it in the revised version. We moved that sentence to the section where we explain redistribution patterns in the discussion. As mentioned before, we make sure to carefully maintain the terms and presentation of the wording.

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