Hydrology and
Earth System
Sciences
Discussions

Interactive comment on "Coffee and shade trees show complementary use of soil water in a traditional agroforestry ecosystem" by Lyssette E. Muñoz-Villers et al.

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Received and published: 18 October 2019

We thank Adriá Barbeta for his positive and encouraging comments giving us the opportunity to further improve the article. Please find below our response to your comments.

[1] Although my general assessment of the manuscript is highly positive, I miss some caution regarding stable isotope techniques. While this is a well-established approach, recent studies pointed to methodological issues linked to fractionation processes within the soil matrix (Orlowski et al., 2018; Gaj et al., 2019; Oerter & Bowen, 2019; Oerter et al., 2019), along the soil-plant continuum (Vargas et al., 2017; Barbeta et al., 2019)

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or within plant tissues (Zhao et al., 2016). Not all ecohydrological systems may be affected by those fractionation processes, and oxygen isotopes seem to still be highly reliable (Zhao et al., 2016; Vargas et al., 2017; Barbeta et al., 2019). Still, in Fig. 3, I observe that xylem water isotopes do not match very well with soil water isotopes from either depth. This is clearer for shade trees. A similar pattern arises in the deuterium excess boxplots. A thorough consideration of potential fractionation processes would require extensive additional analyses, which I think that it is not realistic to ask the authors to do. A more plausible solution is an explanation on why the authors think that fractionation processes are not relevant for their study. It might also be considered to run MixSIAR models separately for oxygen and hydrogen isotopes to check if there are significant discrepancies between them (as in Evaristo et al., 2017; Barbeta et al., 2019). As I said, it is known that fractionation processes do not affect in the same proportion oxygen and hydrogen isotopes. In any case, I believe that these emerging issues cannot longer be ignored by plant water source studies using stable isotopes.

Reply: We agree that fractionation process may, and can no longer be omitted/discussed in the types of data our study presents. In fact, one of our co-authors has been an advocate and champion of doing the best possible research to discover when such affects might play a role (see Brantley et al. 2017; Oshun et al. 2016; Penna et al. 2018). Calculating the isotopic composition range of xylem water and the considered sources across sampling periods and seasons, it is observed that all shade trees (-7.6 to -3.6 for $\delta 18O$, and -65.5 to -32.2 for $\delta 2H$) and coffee plants (-6.3 to -0.6 for $\delta 18O$ and -46.5 to -9.6 for $\delta 2H$) fell within the range of the soil water pool (-11.1 to -0.9 for $\delta 18O$, and -83.4 to -11.9 for $\delta 2H$) during the 2014 dry season samplings (Fig. 3a). In the 2017 dry season samplings, we again observed a good isotopic match between the tree xylem water (-6.0 to -3.2 for $\delta 18O$, and -56.7 to -34.5 for $\delta 2H$) and the soil pore (-7.5 to -1.6 for $\delta 18O$, and -54.8 to -19.0 for $\delta 2H$). However, for the coffee plants, the xylem water (-4.4 to -1.1 for $\delta 18O$ and -39.6 to -7.9 for $\delta 2H$) had more enriched $\delta 2H$ values in comparison to soil water (Fig. 3b). In the 2017 wet season sampling, a very small mismatch was detected in $\delta 2H$ between xylem water of coffee (-5.4 to -4.4

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for $\delta18O$ and -42.2 to -34.5 for $\delta2H$) and soil water (-8.5 to -4.1 for $\delta18O$ and -70.5 to -37.5 for $\delta2H$), meanwhile the trees (-6.2 to -4.2 for $\delta18O$ and -60.6 to -45.6 for $\delta2H$) showed again a good overlap with soil water (Fig. 3c). Based on these results and following the reviewers suggestion, we will carry out some tests to evaluate the effects of deuterium fractionation, in particular for the coffee water samples, by running a simple mass balance approach using hydrogen isotopes only, although we are aware that single isotope ratio approach in multiple water source model could lead to erroneous results due to the overlap of feasible solutions, with poor constrained of uncertainties (see Parnell et al., 2010). In that case, Bayesian mixing models using both deuterium and oxygen isotopes could produce more reliable estimates and uncertainties (Evaristo et al. 2017). Finally, we will add additional explanations in the discussion about potential fractionation processes and their effects on the quantification of the plant water sources.

[2] Minor comments L38 It is not completely clear what does 'precipitation conditions' mean.

Reply: We will clarify this in the manuscript.

[3] L65 Species name (Cedrela odorata) should not be in capital letters.

Reply: Agree. We will make the correction.

[4] L191 The high clay content is likely to produce soil water isotopic fractionation (Oerter et al., 2014).

Reply: Since it has been shown that soil samples containing a high clay fraction might affect the quality of the soil water extraction, and therefore the isotopic composition of the bound water, several papers have suggested that investigations should now incorporate information of the soil hydro-physical properties, and more importantly for clayey soils, information about the cation exchange capacity (CEC), as Vidal and Dubacq (2009) have pointed out that the effect of this interlayered space/water in clay-rich soils

can be indirectly evaluated with CEC. For our study, we did determine other soil physical and chemical properties such as CEC. Therefore, we are going to incorporate this information in the manuscript to show that the contribution of this interlayer water bound in the clay mineral structure was small for our soils, and therefore of little significance for the entire isotopic composition of the extracted soil water, and for the mixing model results (see also our reply to a similar comment made by reviewer #1).

[5] L218 The sampling of different plant parts in coffee plants and shade trees (cores VS branches) could have led to a different proportion of internal plant water pools in the xylem water samples of each group.

Reply: Agree. However, for the coffee, it was not possible to collect a xylem core from the main stem as for the trees without considerable damage, because of the smaller stem diameter of the coffee plants. Therefore, to sample comparable plant xylem water pools between trees and coffee, segments ($\sim$6 cm) of mature branches were cut near the main stem for the coffee plants.

[6] L223 I assume that bark was peeled off from coffee shrubs, too.

Reply: The bark from the branch segments of coffee shrubs was not peeled off ($\sim$1mm in width around the segment), because doing so would have taken considerable time and thus potentially expose the sample to evaporation; we will add this information in the text.

[7] L298 Recent precipitation, especially in periods with relatively wet soil conditions, could in fact percolate faster towards deeper layers. So, rainfall is not necessarily representative of near surface soil water.

Reply: We totally agree and we have revisited this assumption in response to your comment and Reviewer #1 comments. Since each isotope sampling campaign was preceded by at least 6 days up to 22 days without or with minimum accumulated rainfall (< 5 mm) (L235-236), we acknowledge the difficulties to consider rainfall as a potential

source of near surface soil water. Therefore, we are going to use the isotopic composition of the soil at 5 cm depth as a source for near surface soil water. Thus, the discretization of the mixing model originally presented will be modified in the revised version. It is important to mention that we moved already to perform some statistical tests to define the new classification of the soil water pool. Based on the outcomes, the soil water pool will be divided in the following compartments: near surface water (5 cm depth), shallow (15 cm depth), intermediate (30 cm depth) and deep (average of 60-120 cm depth) soil water sources. Preliminary runs of the Bayesian mixing model using this new discretization and without or with the informative prior data continue to show a complementary water use strategy between trees and coffee plants during the dry and wet periods investigated.

[8] L304 The use of prior information is a very interesting point of the study.

Reply: We appreciate your comment.

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