Anonymous Referee #2

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I largely enjoyed reading this paper by Kuhlemann et al. In fact, I thought it got better as I progressed through the manuscript. The paper describes hydrometric measurements, stable isotope variation and isotope-based estimates of young water fractions and transit times in three plots designed to represent different green spaces in the urban environment. I think that interest in aspects of urban hydrology is growing and that studies like this are needed to continually improve our understanding of processes in heavily human-impacted systems. There are a few issues with the paper, but in total, I do not think these issues are dire enough to prevent the paper's eventual publication. My suggestion is along the lines of a "major revision".

Thank you for these positive comments.

From an experimental design standpoint, it is unfortunate that replication is somewhat minimal. There is some within-plot pseudo-replication of certain measurements, but I remain a little hung-up on trying to assess whether the grass plot, shrub plot and tree plot are indeed representative of what one might come across in an urban space and whether the measurements and findings really do represent the breadth of variability that exists naturally. That said, there is a rich dataset here and I do believe that the authors can mostly move forward with what is written. I would suggest that the authority of the writing should however be tempered to match the lack of replication (and therefore the lack of understanding of heterogeneity or representativeness) and at some point, be more explicit in the paper about how replication with the necessary investment into these types of plot studies is not always feasible – and finally, how the lack of replication leads to some unknown uncertainty.

This is a valid point. We tried to cover heterogeneities in soil and vegetation cover by distributing our soil sampling across different locations in the respective vegetation plots and taking duplicate soil moisture measurements and spatially distributed isotope measurements. However, as in most studies, resources limited the degree of replication that was possible. While we agree that more work needs to be done to put our results into a wider context of other parks across Berlin, such work was beyond the scope of this plot-scale study.

However, we plan to address this in future research and are currently undertaking similar investigations in different parks across Berlin. This sampling will complement our current study, inform on the representativeness and facilitate an upscaling of our findings to the city-scale. We will stress this more in the revised manuscript.

I found the general premise of the writing of the introduction and parts of the discussion/ implications to be not as directly related to the work as I would hope. There is significant context given to climate change and irrigation, but I would suggest that the experiment does not hit squarely on either all that well. Irrigation in most temperate urban spaces is not much of an issue. Even if it is in the future, I'm not sure this work is directly transferrable to answering much about that. For climate change, the work does fit well with a drought scenario, but there's no real "change" that is within the design of the study. Perhaps the more direct way forward is to couch the paper more about soil water dynamics in some typical urban greenspace areas under conditions affected by recent drought. This is mostly what is already here and thus, wouldn't be too much of a pivot.

Again, this is a valid point and was raised by Reviewer 1. In the revised manuscript, we will significantly cut down the implications for general urban water demands in the introduction. Rather, we will stress the distinction between urban areas where water shortages and irrigation of green spaces area already an issue; and, in contrast, more temperate regions where, so far, the irrigation need of urban green has been limited. However, in cities like Berlin, the last years were so exceptionally warm and dry that city planners had to start irrigating urban trees. We therefore believe that irrigation of urban green in more temperate regions will gain importance in the future and that understanding water cycling of non-irrigated urban green spaces in these areas is important, as could help inform on which vegetation types will have higher irrigation needs in the future and therefore facilitate the implementation of sustainable urban irrigation strategies. This will also be stressed in the revised manuscript. We will also emphasize the need for longer study periods for a more complete picture.

The use of stable isotopes, especially through time, is quite novel, and the title of the paper does fit well with a somewhat differently focused introduction. It would not be too much a stretch to wait until later in the discussion to make the fuller climate change and future

urban water management. Setting the scene this way up front just does not quite represent the work effectively in my opinion.

We will adapt this aspect in the introduction of the revised manuscript. While we agree that the wider climate change context is not needed here, we will, however, stress why our study is important in the context of increasingly warm and dry conditions in temperate regions, as this is directly connected to our study area.

The results section is described in a pretty dense way, especially in its first half. It would benefit in readability if the authors tried to synthesize more toward the principal observations and let the figures partly speak for themselves, at least a little bit.

Thank you for this suggestion. We will condense the first half of the results section of the revised manuscript.

Finally, this is quite squarely an ecohydrological study, but the ecological part of that is somewhat lacking in the discussion. Are all grass-covered, shrub-covered and tree covered soils in urban systems really expected to act according to the study's observations? What feedbacks might we expect in a changing climate for different vegetation covers? Do we know much about how species composition/community composition might impact on the observations from the study?

These are all interesting questions. However, our current plot-scale study does not yet cover a spatial or temporal extent that would allow a sufficient answer to them. Rather, addressing these questions will require more extensive field work, longer observation periods and potentially also new modelling approaches. We will sketch out our plans to take on these approaches in the future in the discussion of the revised manuscript.

Some more specific comments:

Line 2: Is maintaining the water supply for green infrastructure really a particularly serious issue in temperate climate cities? In many circumstances, the purpose of green infrastructure is largely to help control too much water on the surface of the landscape.

We will rephrase this in the revised manuscript.

Line 6: “effects” of? Vegetation type?

We will look into this and potentially rephrase in the revised manuscript.

Line 25: is climate “breakdown” really a term in common use? Line 25: abstractions, or extractions?

This paragraph will be removed in the revised manuscript, in order to shorten and focus the introduction.

Line 117: The study description could use a bit more (couple of sentences) in terms of fundamental experimental design explanation.

We will add more details on the rationale behind the experimental setup throughout the method (and study site) section of the revised manuscript.

Line 141: What silicon? This sentence could use some editing. Are you trying to explain that there was some sort of silicon septum on the bag?

Yes. Thank you for pointing this out, this information was apparently lost in our editing process. We will clarify this in the revised manuscript.

Line 226: How relevant are stream water and groundwater in the context of this study exactly? The "experiment" is more a plot-scale experiment, so this seems to be a brief, but unfocused part of the study.

We included this information here for context. However, we agree that the information on the isotopic composition of surface water may be of minor importance for this paper, as the plot-scale study site does not include and is not directly adjacent to a larger urban stream as sampled in other areas of Berlin. However, we believe that the isotopic composition of groundwater is relevant for this study, as it allows a comparison between the sampled soil water (especially at 90 cm) and the groundwater at depth, potentially providing information on recharge sources. Therefore, we would prefer to keep the groundwater values in our plot.

Line 271: This first discussion paragraph is a pretty long paragraph without a good central theme, but rather quite a few disparate points being made. Could it be broken up a bit to focus the main points better?

We agree and will re-structure and condense this section in the revised manuscript.

Section 5.2: I found this section quite interesting and well explained. It hits me that it would be nice to have an idea of field capacity in order to situate this a bit more closely with deeper percolation and eventually groundwater recharge. This might not be possible, but could it be inferred/estimated from the soil moisture time series maybe?

This is an interesting suggestion. We will try to address this by looking into the soil moisture data and available literature for this area and include this information in the revised manuscript.

Line 378-381: For context to some of my earlier comments, I found this sentence to best situate the study into a discussion of climate change.

Noted.

Line 381-382: Something is oddly explained here given summer and spring are indeed 50% of the year.

This paragraph will be rephrased or possibly omitted in the revised manuscript.

Descriptions related to the word “depth” such as at line 412, but I believe maybe elsewhere: it is better not to use higher/lower in relation to depth. Deeper/shallower is easier to understand.

This is a good point. We will change this terminology throughout the manuscript.

Figures and Tables: I think these are nicely done.

Thank you.

I have a few comments.

Figure 3: it took me a minute to realize that u-norm is only relevant to the treed plot. I would suggest that the caption needs some editing to more clearly describe what is being regressed against what. Also, given that most of the p-values in the associated Table 5 are not statistically significant, is it actually meaningful to include linear lines of best fit for the insignificant relationships?

Thank you for pointing this out. We will remove all linear lines representing statistically insignificant correlations. We will further rephrase the figure caption, pointing out that measured u_{norm} only refers to the tree site.

Figure 4: Though clear in the paper, the labelling of this figure could be more specific about the measurements being soil pore water in grassland, shrub, trees - or at least make clear in the caption. Otherwise, one risks quick readers thinking this is isotope information in water within grass, shrub or trees.

We will rephrase the figure caption to emphasize that soil water isotopes refer to the sampled bulk water at different depths under the different vegetation types.

Figure 5 and 6: I think the heatmap is an interesting way of doing this, but I honestly would prefer to see the evolution of the soil profile through time, which I think is exactly what is shown in figure 6. I would like the authors to consider if figure 5 and 6 are too closely representing the same information and whether this should be collapsed into just one figure. Could the heatmap part of figure 5 not just be replaced with the entirety of figure 6 (keeping the top part of figure 5 still)?

We understand that these plots present similar information. However, we included both of these plots, as we believe they each stress specific aspects of these results. On the one hand, the temporal development during the growing season and especially the differences in d-excess, indicating evaporative fractionation in the upper soil, are more apparent in the heatmaps in Figure 5. On the other hand, the development in the individual profiles with depth is probably easier to distinguish in the depth profiles of Figure 6. Additionally, this plot provides the perspective of comparing the soil water isotopic composition to incoming precipitation and groundwater. Therefore, we would prefer to keep both plots in the revised manuscript as they add different insights.