Response to Referee Comment 1:

Thank you for your constructive comments and suggestions. We believe addressing these comments will strengthen the paper and improve the message and key points we are trying to convey. Below, we respond to the specific comments, point by point and provide clarifications where necessary. We are confident that through this process we can improve the structure and effectiveness of the paper and communicate the results more clearly. Importantly, we are not sure if the reviewer was made aware that this paper was submitted to a Special Issue on the region "Berlin/Brandenburg" with a very specific local focus. Considering the scope of the SI might help to clarify some of the comments made.

Sincerely,

Dr. Maria Magdalena Warter (on behalf of all co-authors)

This paper by Warter et al. deals with the resilience of streams facing droughts. This is a very interesting topic, as this resilience is due to complex processes that are dependent on interacting catchment characteristics (climate, geology, pedology, land use, water management practices,…). The study analyses hydrological and stable water isotopes data from a 5-year data set on 2 contrasted catchments in Germany (sizes, geologies, land uses,…).

The paper clearly has a lot of potential and deals with a large amount of data.

** Thank you for this positive evaluation of our manuscript.

However, I found it very long, wordy, and difficult to read, mainly because it lacks focus and precision in the analysis. Therefore, it is complicated for the reader to appreciate the results and the impact of the paper. My suggestion would be to rework the data to be able to present less «raw» and more to the point results. My main remarks and recommendations are listed below:

**We thank the reviewer for the careful review. We agree that the paper will greatly benefit from editing to remove text redundancies and "wordiness, to better highlight the value of the datasets and the additional understanding we gained from it.

With respect to "reworking" the data: we are not entirely sure what the reviewer means. Obviously, we cannot "reanalyze" the data BUT we will revise the entire text to remove redundancies and partial "wordiness" in the manuscript. We are convinced this will result in a more "to the point" presentation of the results. We also would argue that the chosen analyses make the best use of the unique long-term dataset of stable water isotopes. Other studies of catchment inter-comparisons use isotopic datasets like ours and similar analyses (i.e. storm events, young water fractions, transit times) to study catchment behavior and assess the differential impacts of urbanization and/or climate change on discharge and catchment dynamics (i.e. Bonneau et al., 2018, von Freyberg et al., 2018). However, the wealth of our isotope data set is quite unique (in terms of length and resolution). Therefore, we would refrain from reworking any data, but rather improve the existing figures and text in such a way that they better present the insights gained from this study and highlights the uniqueness and usefulness of such long-term datasets.

1. Focus

It is not clear from the introduction on and in the whole paper what the focus and objectives of the study really are. The Objectives section of the Introduction (l82-104) is very long and wordy.

** We will revise the introduction, shorten it and remove any redundant information.

Do the authors deal with seasonal patterns of flow response?

** yes.

Response to rainfall events?

** yes.

Response to climate change?

** no.
Recovery from drought events?
** No
What is the temporal scale of interest?
** we don't

Similarly, the title of the paper indicates that the main focus of the paper lies in isotope tracer results, but there is also a very long «classical» hydrologic analysis that is not very well articulated with the isotope sections. This lack of clear focus is really a problem when we come to results interpretation and conclusions.
** Analysing stable isotopes in hydrology only fully makes sense when conducted within a "general" hydrological analysis. The main novelty of this manuscript stems from the use of isotopes, as it gives context to understanding the different catchment responses.
However, we acknowledge the potential confusion and will condense the mentioned paragraph (L 82-104) to give a clearer outline of this study and its objectives.

That said, the focus of this paper was to firstly make use of the extensive datasets of daily stable water isotopes over multiple years and to study seasonal streamflow patterns of two (admittedly) contrasting catchments in the Berlin/Brandenburg region. This is addressing the scope of this SI, so the focus on drought was chosen to fit with the focus of the special issue, with the aim to understand the impact of hydroclimate forcing and anthropogenic water management. So, in a sense we are contrasting the extremes of heavily managed urban and agricultural extremes. Regarding temporal scale, our analysis is based on daily isotope and high-resolution discharge data over 5 years, focusing on seasonal dynamics. We will articulate this more clearly in the objectives section (temporal scale, key focus area) and also form a clearer hypothesis that guides the reader.

2. Selection of the catchments

As far as I can see, the catchments are very different in all aspects: climate (although this part is not very clear), sizes (the urban catchment is much larger), land use of course, but also geologies. The urban catchment is also heavily managed, with water inflow from a WTTP and flood regulation (+ other minor unclear details, see detail remarks below). Are these catchments really comparable? What is the point of comparing them since they are so different? In the paper they are not really compared, the results are shown and discussed sequentially each time. It makes it really hard to draw general conclusions from this juxtaposed study and limits the impact of the paper.
** We agree that the sequential presentation of results may not be the most effective, and will edit the text in a way that uses more comparative language and also avoids repetition.
The catchments are both within 100km of each other and importantly, both are tributaries of the river Spree (with a catchment size of >10000 km2), which is a major water provider to the City of Berlin. Again, we would like to repeat that the focus of the Special issue where we submitted this paper to was on climate effects on water resources in the Berlin/Brandenburg region. Therefore, this study fits perfectly into the scope of this SI. We will make this clearer in the revision.
The catchments' regional climate / climate zone is therefore similar although the experiences differences in their local climate. Otherwise, in terms of their size, land use, geologies and management they are very different. But we chose this specific comparison as the urban catchment – while larger, did resemble the rural catchment in land use prior to the advanced urbanization. Our goal was to use these two contrasting catchments to understand baseflow responses following anthropogenic impact and extensive management, which is still somewhat underappreciated in hydrological studies.

We acknowledge that traditionally hydrological catchment comparisons tend to focus on catchments of similar size and characteristics, there has been plenty of previous international site comparison, sometimes spanning large environmental or climatic gradients, (i.e. Tetzlaff et al., 2009 a, b; von Freyberg, 2018) to assess differing catchment responses to climate forcing. Therefore, we believe that there is major value in the comparison of these two catchments, as it is precisely the juxtaposition of heavily managed urbanized and rural near natural streams environments, that are of interest in times of declining streamflow permanence and extreme events (droughts and extreme rainfall).

3. Methods

For the hydrological analysis, many indicators are mentioned, again with a confusion between seasonal patterns and response to storm events. We do not know which indicators were actually calculated, and we lack a few basic informations about typical orders of magnitude on the catchment to appreciate theses choices (eg how many events were selected, average characteristics, typical discharge values and so on). A table summarizing all the indicators that were actually calculated and for which objective would be very welcome.

** We acknowledge that there are quite a few indicators and parameters presented. Table 1 was meant to provide the necessary hydrological context to the annual differences in streamflow behavior (Q5, Q95, minQ, maxQ, baseflow index and runoff) between the two catchments.

Most of these indicators (i.e baseflow index, runoff coefficient, Q5 etc) are standard hydrological parameters that are calculated from the available data. We explain how they were calculated in the relevant method section (Section 3.1 Climate and hydrological data, L167 – 175).

We will provide an additional table summarizing the indicators and data its based and propose to include it in the supplementary material to avoid cluttering the main manuscript. This way, an interested reader can get the necessary information and background.

Regarding reference values and orders of magnitude, we will provide additional information in Section 2 of the study catchment description.

For the selection of rain events, this was also described in the section (L176 – 186). We will however, make sure the text is clearer on which parameters are calculated and which are measured to avoid confusion.

Is flow intermittence a topic of interest in the study? If yes, specific indicators could be looked at, plenty can be found in the literature. Same for «elasticity (l442). If the «recovery» from droughts is the main topic of interest (as stated in the paper's title), specific indicators can be also calculated (definition of drought events etc). I am not a specialist at all of isotope data, so I was not able to review specifically this section, but I would have appreciated a little more pedagogic explanations (perhaps with a schema explaining the various indicators calculated).

** The Berlin/Brandenburg region experiences increasingly stream intermittence. Our research group has published on this before, and we will briefly add this to the study site section citing the following papers - Luo et al., 2024; Ying et al., 2024; Kleine et al., 2021. Although we acknowledge the issues of intermittency in this paper, the regulation of the urban stream by waste water means that it is not directly an issue there, which is why we have not provided the metrics mentioned.

Also, recovery of drought is not the main focus. As stated above, the analysis revolves more around a general understanding of streamflow generation and response under temporally variable hydroclimate forcing, which included a drought period. Focusing only on drought responses would require a different kind of analysis and indeed different indicators and definition of drought periods/events etc. which is beyond the scope of this study (but was addressed in other studies by the group).

We realize the complexity of isotope data for the less experienced reader and appreciate the suggestion of additional explanations. However, we would like to point out that in the relevant method sections (3.2 and 3.3) we did provide extensive information regarding data collection and calculation of the different parameters (i.e. Local Meteoric Water line, lc-excess, water ages, transit times). We believe this information should give enough context and information for reproducibility and understanding. We respectfully disagree to provide an additional "schema" as this would not add any value to the interpretation or presentation of results. However, we will make sure to also edit the text in this section to be more succinct and focused for easy understanding.

4. Results

The Results section is very descriptive. The hydrology sections are lengthy stories of what happened in each catchment year after year, where a more synthetic analysis would have been expected. The Figures don't help. Figs 2-6 are extremely complex and contain way too much superimposed information, which is not necessary. For example in Fig 2, instead of presenting a full 5 year long hydrograph at 15 min time step that is completely illegible, it would have been much more interesting to present interannual flow regimes to study the seasonal patterns, and more focussed events for specific analyses. The authors also don't choose between comparing the different years and comparing the catchments. As a result, it is impossible to obtain a clear picture of what is going on.
**We realize there is a lot of information presented in the results section and appreciate the opportunity to revise it.
We will revise and shorten the entire result section to be more precise. Regarding discharge measurements presented in Fig. 1 - we will switch the presentation of 15min data to hourly data to make it more legible. We also realize that colors are not ideal and will change this to a more legible color scheme. We believe that showing the full 5 year hydrograph in relation to precipitation is important to provide a visual context of the different streamflow regimes and responses to climate forcing.
We present interannual perspectives on flow regimes in Figure 4 through the flow duration curves and discuss in Section 4.3 the seasonal patterns. Referee #2 suggested to add double mass curves to show cumulative precipitation and discharge, which we will do.
In response to similar comments by Referee 2, we will restructure the results section in such a way that we start with a general description of precipitation patterns and rain events. For this we will merge section 4.1 and 4.4 and reduce the text to present the most relevant results regarding the differences in the seasonal distribution of rainfall and dry periods, and the different storm events.
This would be followed by Section 4.2 – a description of the seasonal streamflow patterns.
Then Section 4.3 will deal with streamflow isotope patterns. Finally, Section 4.4. will present results regarding young water fractions and mean transit times.
We would argue that the isotope figures (Fig. 3, 5, 6) show an acceptable level of complexity similar to figures in other studies doing the same kind of analyses (i.e. papers cited in introduction, method and discussion sections).
We believe this way the results section will be more comprehensive and provide a better overview and understanding.

Some of the results in the text are also not supported by Figures, eg the section on storm events refers to the general hydrograph on Fig2 where nothing can be seen, and numeros correlations are mentioned in the text without supporting Figs or Tables.
**As we propose to merge the section on storm events (currently Section 4.4), this should clear up the concerns by the Referee. We will also make sure that any correlations will be referenced to the relevant Figures/Tables.

I was not able to review the Isotope sections but the corresponding Figures seem also very complicated and unclear to me (eg in Fig 3: I really don't see the differences between the catchments. For both there are points all over the place. More explanations are needed).
**We acknowledge that the symbols may be hard to distinguish in their current form. We will increase the size of the points to make them more visible. However, the representation of isotope results in dual isotope space (Fig.3) is a standard practice and meant to illustrate the variability and range of values found in each catchment. We will make sure that the text is clearer and more concise to avoid confusion and guide the reader through the figure and results. As a general interpretation: the closer the values are together, the less variable they are -meaning a more constant and similar water source is present in a stream, while points spread larger apart indicate greater variability in the source water contributions and seasonal variability.

5. Discussion

The discussion does not bring much in terms of interpretation of results, maybe because the results are so scattered. It is therefore a mix of descriptive talk and more general considerations that are not directly linked to the paper's subject (example blue / green water concepts) or partially repeat what was already said in the Introduction.
**We acknowledge the wordiness and "descriptive talk" and suggest to refocus the discussion to fit better with a redirected focus from the introduction.
We believe that our analyses do allow us to make a general link from the importance of understanding streamflow generation to blue/green infrastructure, especially in the urban environment, and we will write this clearer in the revised manuscript. We argue that first understanding streamflow dynamics in a catchment and understanding the ability of a catchment to store/release water is important to evaluate the effectiveness of such measures, especially in highly urbanized systems. We will clarify the novelty of such analyses – in particular for urban catchments. At the same time, this is also relevant in rural agricultural catchments where water bodies are increasingly important for maintaining blue-green fluxes and biodiversity.
Especially since streamflow generation and intermittency are becoming an increasingly important issue under advancing climate change (not just in the Berlin/Brandenburg region), we also believe it is relevant to highlight the use of stable water isotopes as a valuable tool to develop a more integrated understanding of hydrological dynamics, especially in ungauged basins where hydrometric data is less readily available.
Nevertheless, we will avoid repetition of arguments made in the introduction and also reframe the discussion sections to be more precise and better highlight the results and their implications.

The conceptual model in Fig 7 is a very good idea to sum up and present the conclusions of the study, but it lacks precision. Being too general, it fails to bring forward the results and show the knowledge added by the study. In its present state, it presents traditional hydrological processes, as can be found in any hydrology course and could have been guessed from the start.
** we will revise the figure as follows: we will add flux amounts in mm and water ages in months to link the figure more explicitly to the results. We will also aim to make land use a less prominent feature and focus more on the link to hydroclimate and highlight the aspect of urban water management.

6. Detail remarks

l260: is the drinking water for Berlin city withdrawn from the catchment? This part is not clear.
** Yes, water abstractions occur in the catchment. However, more water is imported into the catchment from the Spree and Havel, as Berlin depends on bank filtration to supply water to the city. We will reword the section to make this clearer.

l119: «flat lowland landscape»: is the only indication that we get about the topography. Is it possible to have a little more information, especially for the readers who are not familiar with the area?

**We will add more information about topography and elevation gradients.

Fig 1: the rural catchment is 60 km² but on the map the gauging station + sampling point is not located at the outlet, the catchment that was actually studied is much smaller then?

**Yes, the entire catchment is 60km^2 but since we are using the gauging station further up in the catchment – indeed the studied catchment area is slightly reduced. We will amend this in the description of the study site and insure this information is conveyed correctly to avoid misinterpretation and confusion.

p13: in the paragraph on seasonal flow regimes, there is a mention of response to precipitation events which is off topic + «evidenced by runoff coefficients»: where are these runoff coefficients? There is no ref to Fig or Table.

**The runoff coefficients were presented in Table 1 (Q/P). We will add reference to the correct Table to avoid confusion.

Fig 5: what are the grey lines?

**The grey lines in the plot have no specific meaning but were a graphical choice. They will be removed to simplify viewing of the plot.

Additional References:

Bonneau, Jeremie, et al. "The impact of urbanization on subsurface flow paths–A paired-catchment isotopic study." *Journal of Hydrology* 561 (2018): 413-426.

von Freyberg, J., Allen, S. T., Seeger, S., Weiler, M., & Kirchner, J. W. (2018). Sensitivity of young water fractions to hydro-climatic forcing and landscape properties across 22 Swiss catchments. *Hydrology and Earth System Sciences*, *22*(7), 3841-3861.

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Luo S, Tetzlaff D, Smith A, Soulsby C. (2024) Long-term drought effects on landscape water storage and resilience under contrasting landuses. *Journal of Hydrology*, https://doi.org/10.1016/j.jhydrol.2024.131339

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Tetzlaff D, Seibert J, Soulsby C. (2009) Inter-catchment comparison to assess the influence of topography and soils on catchment transit times in a geomorphic province; the Cairngorm Mountains, Scotland. *Hydrological Processes*, 23, 1874–1886.

Tetzlaff D, Seibert J, McGuire KJ, Laudon H, Burns DA, Dunn SM, Soulsby C. (2009) How does landscape structure influence catchment transit times across different geomorphic provinces? *Hydrological Processes* 23, 945–953

Ying Z, Tetzlaff D, Freymueller J, Comte JC, Goldhammer T, Schmidt A, Soulsby C (2024) Developing a conceptual model of groundwater – surface water interactions in a drought sensitive lowland catchment using multi-proxy data. *Journal of Hydrology*, https://doi.org/10.1016/j.jhydrol.2023.130550