

## Response to Reviewer 1:

*The manuscript presents a comprehensive database on groundwater levels and physico-chemical properties with high frequency measurements and sampling in the small Weierbach catchment in Luxembourg. This type of data is fundamental for sustainable water resources management, environmental and public health protection and future planning in the face of climate change. In times of dynamic changes in natural environment, we need as much of this type of data as possible from different areas.*

*The description of the data base, the data acquisition methods and the possibilities for their use have been clearly and accurately drawn up. It is evident that the authors have applied rigorous data quality control criteria. And I have no doubt that this database can be a valuable and useful source of information for scientists.*

*However, these are not the first studies conducted with such high frequency. There are experimental catchments in Europe where similar measurements have been carried out for a longer time. Examples include the TERENO experimental catchments in Germany <https://www.tereno.net/>, including the Wüstebach catchment, which is relatively close to Weierbach and with similar environmental conditions. Sampling of groundwater and determination of its chemical properties also takes place there on a weekly basis. It would be good to refer to measurements in other areas; is the research described by the authors part of the current of European research, or does it contribute something more?*

*Secondly, I have my doubts that data collected for one year can be sufficient to determine 'catchment response to hydrological change', 'catchment seasonal variability', 'dynamics between shallow and deeper flowlines' and whether it is sufficient for any modelling. Each year is different and at least several years of data are needed to demonstrate any patterns. Perhaps some statements could be reworded or softened.*

*Thirdly, the authors extensively describe the usage and applications of the data, but what about the weaknesses or limitations of data usage? A paragraph or subsection discussing these limitations and how to address them would be helpful.*

Thank you for your detailed feedback and constructive suggestions, please see below our response:

### 1. **Contextualization with Other Studies and European Relevance:**

We appreciate your point regarding similar datasets, such as those from the TERENO network, including the Wüstebach catchment because this would put this new dataset in a more general/European framework and strengthen its value. Although weekly sampling of groundwater chemistry in European experimental catchments is not new, our study contributes to this body of work by offering **in situ redox potential measurements** directly from the borehole, allowing for real-time data collection. This approach, along with our specific focus on **differentiating shallow and deep groundwater flow paths** in an entire headwater catchment, provides finer temporal and spatial resolution. This data structure aligns with ongoing European research but adds to it by offering redox and biogeochemical dynamics across vertical profiles, aiming to reveal interactions within both shallow and deeper aquifer zones. We will add an additional paragraph highlighting literature review to contextualize the database within existing European research, highlighting both similarities and distinctions.

2. **Duration of Data Collection and Interpretation Limitations:**  
We acknowledge that the one-year dataset is limited in capturing long-term trends, including inter-annual variability in catchment responses, seasonal changes, and flowline dynamics. The first year of monitoring coincided with one of the wettest years in the last decade, which may influence the representativeness of the data. However, in the two years of monitoring, we observed hydrological states that reflect most of the conditions recorded in this catchment over the past 20 years. This suggests that the dataset provides valuable insight into typical catchment-scale dynamics of the measured physico-chemical parameters. We will adjust the manuscript to tone down any claims of comprehensive conclusions and instead highlight the dataset's potential as a foundation for understanding key processes. The continuation of bi-weekly sampling and the existing 10-year dataset will help contextualize these findings and support more robust long-term analyses.
3. **Limitations of the Dataset and Potential Weaknesses:**  
We agree that discussing the limitations of our data, particularly its one-year span, would be valuable for future users. Aside from duration, **technical issues** such as potential probe drift due to temperature fluctuations may impact readings for redox and dissolved oxygen, and we acknowledge this as a possible limitation of on-site measurement techniques. To mitigate this, we have applied temperature correction protocols and intend to include notes on any observed drift in the supplementary dataset. Additionally, as you suggested, we will include a section discussing these limitations and outline how we aim to address them in the future.

Thank you again for your valuable insights, which will help strengthen our manuscript.

**Specific comments:**

Lines 43-45: This sentence requires references.

“Despite widespread recognition of the shallow and deep hypothesis, direct data support of the hypothesis using measured stream chemistry in conjunction with subsurface water chemistry at different depths is rare.”-(Steward et al., 2022)

Stewart, B., Shanley, J. B., Kirchner, J. W., Norris, D., Adler, T., Bristol, C., et al. (2022). Streams as mirrors: Reading subsurface water chemistry from stream chemistry. *Water Resources Research*, 58, e2021WR029931. <https://doi.org/10.1029/2021WR029931>

Line 94: I suggest adding 'level' between groundwater and monitoring.

Will do

Lines 121-127: It is not clear to me whether the field measurements were conducted directly in the borehole or if the water was first collected and then measured. If it's the latter, into what kind of container was the water collected, was the measurement taken immediately after collection or with some delay, and what was the volume of such a sample?

We used a **peristaltic pump** connected to a flow-through cell system with four cells (two in series, and two in parallel for pH and ORP to avoid interference). Groundwater was pumped until EC stabilization, which indicated borehole homogenization. The system was then **sealed at both ends** to prevent external influences, allowing a 20-minute equilibration period before final readings were taken directly from the closed system.

Line 186: Does the provided database from one-year monitoring campaign truly allow us to address the mentioned problems? Isn't there a need for longer measurement series? Perhaps the authors should soften this statement somehow, for example, by discussing the potential of the data, etc.

We agree that a one-year dataset may not capture the full range of temporal variability. This high-frequency, one-year monitoring campaign was designed to add resolution to key parameters that

were suspected to influence biogeochemical processes in the catchment. While the timeframe was constrained by the project's budget and duration, we continued bi-weekly measurements after this campaign, and a separate 10-year bi-weekly dataset is also available. This longer-term dataset will contribute to future analyses and provide broader context.

The primary aim of the one-year dataset is to establish redox ranges and chemistry profiles for both shallow and deeper groundwater in this experimental catchment, offering a foundation for understanding the catchment's biogeochemical dynamics.

Thank you for the suggestion; we will revise the text to reflect these points.

Lines 187-188: The authors mention previous studies, but they do not specify which studies they are referring to. It would be helpful to include references to these studies here.

Lines 200-202: Same as previous. Provide references to these previous studies.

Lines 220-221: Provide some examples/references

Lines 231-233: Same as before. The references are missing.

Thank you for pointing this out. We will add specific references to relevant studies in lines 187-188 to clarify the research background and provide proper attribution.

Lines 248-249: What do you mean by 'extends beyond conventional monitoring efforts'? In other experimental catchments, groundwater measurements have also been conducted on a weekly basis for several years. It would be good to reference these studies and clearly state what is new about your measurements.

By "extends beyond conventional monitoring efforts," we intended to emphasize that, at the **catchment scale**, our high-frequency, on-site monitoring of EC, DO, ORP, and pH captures both spatial and **temporal dynamics** in groundwater biogeochemistry. This dataset focuses specifically on redox dynamics across both shallow and deep groundwater zones, providing a depth-specific profile.

We will conduct a brief literature review to confirm whether this dataset is novel in this regard and will update this section with references to similar studies as appropriate.

Line 260: I would rather write about the potential significance of this database, provided that the measurements continue, because can a one-year measurement campaign really address these issues?

We agree that a one-year measurement campaign may be limited in capturing long-term variability. This dataset is intended as an initial step to understand seasonal dynamics and biogeochemical interactions, providing baseline data for key parameters. We agree that its potential significance will increase with ongoing monitoring, allowing us to build on these insights to better address long-term catchment processes.

In the revised text, we will adjust our language to emphasize the preliminary nature of these findings and the added value of continuing measurements over time.

Figure 5. The text refers to Figure 5, which is supposed to show graphs of SO<sub>4</sub> and NO<sub>3</sub> concentrations, but they are missing from the figure. Additionally, there is no need to repeat the DO and pH graphs on the lower plot, as they are already present on the upper one.

Thank you for noticing this. The labels in the legend of the lower plot in Figure 5 are incorrect; they should refer to  $\text{SO}_4$  and  $\text{NO}_3$  rather than DO and pH. We will correct this to accurately reflect the data shown in the figure.

**Technical corrections:**

Line 24: remove dot after “reactive rock formations”

Will do.

Figure 4: I would eliminate the black outlines of the circles, as it is difficult to distinguish the colours with such a high density of points.

Will try this and potentially other solutions to address the problem you have pointed out.

Table 1: Please standardize the notation of the coordinates in either uppercase or lowercase letters (WGS or wgs).

Will do.