UNIVERSITY OF SILESIA
IN KATOWICE

Sosnowiec, 2 October 2025

Authors' response to Referee #2

RC2: 'Comment on egusphere-2025-3841', Anonymous Referee #2, 30 Sep 2025

General comment

The manuscript presents a novel application of EEMMA to RBF in Poland and reveals a strong link between isotopic evidence and catchment processes. The Materials and Methods section is comprehensive and detailed enough, providing clear descriptions of the study site, thorough field and lab methodology, transparent datasets, analytical approaches and clear methodological insights into EEMMA application. The discussion and conclusion provide an international context for the results and offer practical recommendations to RBF operators, justifying high-resolution monitoring.

The primary concerns relate to the language style, with overly long sentences and some redundant phrasing that disrupts the flow. First and foremost, however, the authors should clarify the nomenclature of water drawn from RBF wells. In my opinion, the term' groundwater abstraction' is not appropriate in the context of water drawn from the RBF wells. As you correctly pointed out in the Introduction, it is a mixture of surface water and groundwater. I hereby propose changing it just to 'water abstraction' or another term that emphasises that it is a mixture of water from different sources. In addition, it would be beneficial to briefly address the geological structure and hydrogeological conditions in the upstream catchment area, and to include a discussion how these aspects influence the results.

I would express my appreciation for the comprehensive supplementary data.

Considering the innovative character of the study and its effective presentation I recommend the manuscript for publication with minor corrections. Please refer to the attached PDF file for details.

I would like to congratulate the authors on their hard work and wish them the best of luck with the final publication.

REPLY: We would like to thank you for your time and work to review our manuscript. We are pleased you found our work innovative and suitable for HESS. We also appreciate your insightful comments provided in the PDF. We generally agree with the comments, but in a few cases, we provide an alternative explanation below.

Specific comments

General remark: Similar to our response to Referee #1, we did not list every comment from the attached PDF file here, since many of them were also of an editorial/stylistic nature. Please note that if a line with a Referee's suggestion is not mentioned below, it means that we agree with the comment and will implement it in the revised version of the manuscript. Therefore, below we present only responses to suggestions that, in our opinion, require more extensive commentary.

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L. 40: I think that groundwater management is not appropriate here. Do you mean the management of water abstracted from RBF facilities?

REPLY: Yes, we will correct this part of the manuscript, but please see also our response to L. 76 regarding groundwater/water/bank filtrate terminology.

L. 66-67: Unclear what this refers to / This sentence is incomprehensible. Please rephrase it.

REPLY: This part will be corrected. We suggest:

"…Based on this example, we present recommendations for water monitoring and data analysis for RBF site operators. We believe that effective monitoring of an RBF facility requires considering data from the upstream catchment of the river and the interpretation of multiple tracers. Therefore…"

L. 76: In my opinion, the term' groundwater abstraction' is not appropriate in the context of water abstracted from the RBF system. As you correctly pointed out in the Introduction, it is a mixture of surface water and groundwater. I hereby propose changing it to 'water abstraction' or another term that emphasises that it is a mixture of water from different sources. I suggest that the corrected term be consistently used throughout the manuscript. The term' groundwater' should be reserved exclusively for groundwater.

REPLY: We fully understand and appreciate your comment and agree with it from the hydrogeological point of view. Indeed, the abstracted water may be predominantly bank filtrate or a surface water–groundwater mixture, depending on which wells we refer to.

However, since the water is drawn from the subsurface (or underground) saturated zone by production wells, we believe it is still valid to use the term *groundwater* in the paper (since, technically, it is not wrong). In our view, this terminology helps maintain clarity, especially for readers who are not specialists/experts in our field, as they intuitively associate any subsurface water extracted by wells with groundwater, regardless of the type of well recharge sources.

That being said, to address your concern, we propose a slight revision of the manuscript to clarify this point explicitly. At the beginning of Section 2.1 (Study area), we propose stating that when we refer to groundwater in the production wells, we consider that its main contribution can be linked to bank filtrate/mixture. The corresponding text can be adjusted as follows:

"…The investigated RBF site is located in the village of Kępa Bogumiłowicka near Tarnów, Poland, and is run by the public utility company Tarnów Waterworks Ltd. By groundwater abstraction, it provides about 30% of the drinking water supply for the Tarnów region. We want to emphasise that, although we use the term "groundwater" for convenience when referring to water abstracted by the production wells at the RBF site, its main component may in fact be bank filtrate or a mixture of river water and native groundwater, depending on the well location. …"

Figure 2 (it will be Figure 1, considering Referee #1's comment): The boundary between the Slovak and Polish parts of the catchment area is invisible. Consider signing the names of countries, changing line pattern or colouring the polygons.

REPLY: We will correct the Figure as suggested.

L. 96: It is worthwhile to briefly mention the geological structure and hydrogeological conditions in the catchment area upstream of the RBF system and comment in the discussion how this aspects influence results.

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REPLY: We agree that the upstream catchment geology and hydrogeology undoubtedly shape river water characteristics. However, in our view, a detailed description of these aspects would go beyond the main scope and objectives of the paper, which is focused on tracer-based monitoring and methodological insights into RBF site management. The upstream influences are already reflected in the isotopic and hydrochemical signals analysed, and we preferred to keep the discussion concise and centred on the methodological framework – we would not want to extend it further at this point. We acknowledge, however, that a more detailed investigation of catchment geology–hydrology linkages could be an interesting direction for future research. Therefore, we cite a very comprehensive report in the manuscript that provides a holistic description of the hydrogeological conditions of the entire Dunajec River catchment:

Kruk, L., Kapuściński, J., Leśniak, J., Górka, J., Reczek, D., Biedroński, G., Hotloś, Ł., Orlak, M., Tkaczuk, W., Bubrowski, T., Augustyn, K., Czechowska, B., Herbich, P., and Przytuła, E.: Hydrogeological documentation establishing the disposable groundwater resources of the balance areas: the Dunajec River catchment area and the Czarna Orawa River catchment area. National Geological Archive, Polish Geological Institute – National Research Institute, Warsaw., 2017.

To meet expectations, we will add a sentence to the manuscript referring the reader directly to this document in the context of the hydrogeology of the entire catchment area:

"…The unconfined Pleistocene aquifer, composed mainly of alluvial gravel and sand with well-rounded pebbles, overlies thick Miocene clays and is the area's only aquifer. The RBF site is covered mainly by thin Holocene silts and organic mud; further inland, clayey silt lenses also occur (Fig. 3). The hydrogeological conditions for the entire Dunajec River catchment are described in detail in the documentation carried out by Kruk et al. (2017)…"

L. 105: I suggest using the proposed abbreviation RBF consistently throughout the text when referring to riverbank filtration.

REPLY: We will correct this.

L. 275: Following the correction of the term relating to water abstracted by RBF wells, it is likely that the use of "native" will no longer be necessary. I therefore suggest removing it from the entire manuscript.

REPLY: Please see our response to L. 76. Following this logic, we insist on staying with "native groundwater" in the paper, as we define it in L. 129 as "regional groundwater recharged via precipitation into the Tarnów aquifer system".

L. 280: Sentence correction needed for clarity. I propose: Mean daily flow rates of the Dunajec River ..... or The Dunajec River mean daily flow rates .....

REPLY: We will correct with "Mean daily flow rates of the Dunajec River".

L. 307-309: In my opinion this is a discussion paragraph.

REPLY: Even though it may be a sentence suitable for a Discussion, we propose to leave it as it is, since it directly provides the reader with information on why this Section (3.2) is needed in the manuscript, and we think it also fits well in this place.

L. 349: Please, do consider replacing the term 'river water in groundwater ...' with another term.

REPLY: Following the logic described in the reply regarding L. 76, we propose to leave the sentence as is.

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L. 351-352: This sentence is unclear. Firstly, there is no connecting clause to help the reader understand the text. Secondly, could you clarify whether you are suggesting that groundwater constituted a much larger proportion in wells located further inland from the river?

I believe that the clarity of the research could be improved by applying this convention or a similar one consistently throughout the manuscript.

REPLY: In line with the comment, we suggest a slightly more detailed description:

"…River water fractions in the groundwater of the production wells, considering all used tracers, were 92–100% for S31, 87–100% for S36, 39–51% for S37, and 46–59% for S39 (mean values ± standard error of the estimated mixing fraction (SE); cf. Table S8). Wells S31 and S36 are located in a row closer to the Dunajec (Fig. 2), where a dominance of river water recharge was observed. On the other hand, results from wells S37 and S39, located in a farther row (Fig. 2), demonstrated that native groundwater inflow constituted a notably higher fraction of the groundwater abstracted from these wells…"

L. 353-354: The sentence is unclear.

REPLY: In this part, we tested how the EEMMA will work for different periods of the year, when a) isotope signals of the end-members differed, and b) isotope signals were very similar.

We propose changing the sentence to: "…The results of river water and native groundwater contribution to production wells recharge during the snowmelt period (January–June 2023) closely matched the results for the whole observation period (October 2022–October 2023; Table S8)…"

L. 366-368: This paragraph deals with the discussion.

REPLY: Our point in including this paragraph followed the same logic as the paragraph in L. 307-309: To directly inform the reader why this Section is needed in our paper and what added value it brings. Hence, we suggest leaving it as is.

L. 393: This passage is unclear. What is spatial gradient in aquifer recharge dynamics?

REPLY: The closer to the river, the more river water contributes to the water abstracted by the wells / The further from the river, the more native groundwater is abstracted by the wells.

We can add this explanation to the manuscript.

L. 394: This phrase sounds a bit awkward, please rephrase it.

REPLY: We suggest deleting this sentence from the manuscript.

L. 425: This is unclear, consider changing the wording.

REPLY: We propose: "…in the groundwater abstracted by the production wells at the RBF site…"

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