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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Quantifying flood-water impacts on a lake water budget via volume-dependent transient stable isotope mass balance" *by* Janie Masse-Dufresne et al.

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In this manuscript entitled "Quantifying flood-water impacts on a lake water budget via volume-dependent transient stable isotope mass balance", the authors focus on an artificial lake and justify their study by stating that "[understanding] the relative importance of the hydrological processes in lakes can also help to depict the vulnerability and/or resilience of a lake to pollution". They aim to develop a predictive

model of both atmospheric and water balance controls on isotopic enrichment, quantify of flood-water inputs to the lake, and conduct a model sensitivity analysis was conducted to evaluate potential sources of uncertainty. Overall, the manuscript is of appropriate length and well written. Figures and tables are also of good quality and rich in information without being too crowded. While I enjoyed reading this manuscript, I think that the authors need to make a strong case for the broader relevance, impact and transferability of their methods or conclusions, in addition to revisiting the structure of manuscript. My most major criticisms are as follows:

RC2-1. ** In its present state, the manuscript pretty much reads like a case study report. There is nothing wrong with case studies per se, as the uniqueness of place makes the conclusions of many papers inherently site-specific. That being said, I think that the authors should try to extrapolate their conclusions (or speculate about how their conclusions might extend) to other lakes (artificial or not) in Canada, North America and around the World. What makes Lake A and Lake DM different (or not) than other lakes where similar isotope mass balance approaches have been used in the past? In other words, what makes the present study novel? What are the really key contributions that represent an advancement to the science – and that may be relevant beyond the particular site that the authors focused on? Can the results be extrapolated to depressional wetlands which are affected by flooding as well? And if results and conclusions cannot be extrapolated, what about some of the methods applied in the current manuscript?

My asking those questions is not my way to say that there are no novel contributions in this manuscript, but rather to say the authors have not explicitly identified them and should highlight them better.

Answer: Done and clarifications. First, we are grateful to Reviewer 2 for this valuable comment. First, the following material could be added to the introduction at L43 to better highlight the broad relevant of such study:

"Knowledge concerning the surface water-groundwater interactions in flooded environments are of global importance, as there is an increasing interest worldwide for undamming rivers and floodplain restoration as management tools for flood risk and/or enhancing ecosystem services (Dixon et al., 2016)."

Another original aspect of our study is related to the approach, i.e., the use of isotopic tools to cope with the impossibility (or difficulty) to perform direct measurements of surficial water fluxes. The following material could be added to the introduction at L51:

"Furthermore, most isotopic mass balance models are applied to contexts where there are no surface water inputs and/or the surface water inputs are quantified by direct measurements (i.e., river stage). However, in floodplains, direct measurement of surface water inflow is difficult (or nearly impossible), while isotopic mass balance models can be useful in providing estimation of the water balance partition with a minimum sampling and monitoring effort."

Concerning the applicability of the method to other environments, please see response to RC2-2.

Besides, we think it is relevant to add the following material to the introduction at L58 to better explain the outcomes of this study:

"The study period spanned a 100-year flood, an event which may no longer occur on dammed rivers (Bednarek, 2001). The present case study is thus a precursor to future research on the impact of restoring the river corridors, as it provides an example of the importance of flood-water inputs on the water balance of a lake in an urban area and during a 100-year flood. This

study also provides insights on the usefulness of isotopic data from lakes to complement the hydrogeomorphic methodology for the delineation of the flooding space of rivers. This concept is an important aspect of the recently developed methodology for determining the freedom space for river by Biron et al. (2014) and which was proven to be an economically viable river management approach (Buffin-Bélanger et al., 2015)."

RC2-2. ** The introduction lacks an overarching goal or research question for the study, as well as specific research objectives or questions. Instead, the last paragraph of the intro just states that the present study builds upon two other studies. The only sentence of the introduction that could be seen as a research goal is the one that reads as: "The main purpose of this study was initially to expand our understanding of flood-affected lake dynamics in the context of a seasonal climate". It is quite vague, though, so I suggest that the authors include some more specific objectives or questions at the end of the introduction. This should also help highlight the novel contributions that the present study intends to make.

Answer: Done. Based on this comment and other suggestions below, we propose the following reformulation of the general and specific objectives:

General objective – The main purpose of this study is to evaluate the importance of flood-water inputs on the annual water budget of a lake located in a floodplain, in order to depict the resilience and sensitivity to changes in the water balance partition and flood-water and/or groundwater quality

Specific objective 1 – Investigate the isotopic framework for the local water cycle

Specific objective 2 – Evaluate the water budget considering reference scenarios (A and B)

Specific objective 3 – Analyze the temporal variability of the groundwater inputs and the sensitivity of the lake to flood-water driven pollution

Specific objective 4 – Demonstrate the implications of flood-water storage on the water balance partition

We could read the following in the introduction (in replacement of L52-58 and L76-78):

> *"The main objective of this study is to evaluate the importance of flood-water inputs, relatively to groundwater inputs, on the annual water budget of lakes located in a floodplain, in order to depict the resilience and sensitivity of flood-affected lakes to changes in the water balance partition and flood-water and/or groundwater quality. To do so, we first aim at investigating the isotopic framework for the local water cycle to verify the applicability of an isotopic mass balance to the study site. Secondly, we quantify the water budget according to two reference scenarios (A and B) to grasp the impact of site-specific uncertainties on the computed results. Then, we analyze the temporal variability of the groundwater inputs and the sensitivity of the lake to flood-water driven pollution. Finally, we demonstrate the implications of flood-water storage on the water balance partition. The water balance is computed via a volume-dependent transient isotopic mass balance model, which is applied to predict the daily isotopic response of an artificial lake in Canada that is ephemerally connected to a* $150,000 km^2$ *watershed during spring freshet and other periods of flooding. During flood events, the surficial water fluxes towards the study lake are not constrained in a river or canal but occur over a 1 km wide area."*

The following material should be added to the conclusion (in replacement of L513-514), to underline the applicability of this method to other environments:

> *"Flood-water originated from a large watershed, extending roughly 300 km northwards from the study site and, thus, draining snowmelt and rain*

> *waters with relatively more depleted isotopic signatures than the local waters. Given the contrasted isotopic signature of the flood-water, the isotopic mass balance model was efficiently applied at the study site. Such isotopic framework is far from being unique. Indeed, most flood events occur in lowlands, while flood-waters originate from highlands (i.e., mountainous environments). Hence, our approach can be applied in many contexts, as flood-waters have a marked isotopic signature.*

RC2-3.** There seem to be a lot of "results" that are listed in Section 3, which most readers would equate to a Methods section (and not a results section). I would suggest that the authors try to reorganize their text a bit, so that section 3 only focuses on methods while section 4 summarizes results.

Answer: Done. We propose moving all section "3.3.2 Isotopic framework" to section "4 Results". Also, we think it is best to move the results of the evaporative fluxes calculation with the Penman equation (i.e., L240-L249 and L259-L270) and the comparison with two other models (i.e., L250-L258) to the Supplementary materials, as this topic is not a specific objective of our research.

RC2-4.** Following up on the previous point: Section 4 does not seem to focus on "plain results" only, as it includes several interpretations, discussions and linkages to the literature. Section 4 therefore reads as a combined Results and Discussion section, which is a bit surprising as there is a separate discussion section later. I suggest that the authors try to better distribute methodological aspects, results and discussions/ interpretation into distinct sections (and sub-sections).

Answer: Done. We made an effort at reorganizing the sections of the manuscript to make a better use of the "4 Results" and the "5 Discussion" sections. Below is the proposed structure (key figures and tables in italic):

4 Results

4.1 Water fluxes and isotopic framework (Figure 3, Figure 4 and Table 1)

4.2 Evaluation of the water budget

4.2.1 Volume-dependent isotopic mass balance (Figure 6 and Table 3)

4.2.2 Sensitivity analysis (Table 2)

4.3 Temporal variability in the water balance partition (Figure 7)

5 Discussion

5.1 Local flood-water marked groundwater

5.2 Importance of flood-water inputs in the water balance partition

5.3 Resilience of Lake A to surface water pollution (Figure 9)
Note that the original subsection "4.2.1 Insights from net water fluxes at Lake A" is not reporting a specific objective of the study, but rather provides a "reality check" by describing the net water fluxes and Lake A volume variation. Hence, we opt to merge it with the newly proposed "4.1 Water fluxes and isotopic framework" section. That being said, we conceive that the results illustrated in Figure 5 could simply be summarized in the text, and we propose including Figure 5 in the Supplementary materials in the revised version of the manuscript.

Also, as requested by Reviewer 1, we propose to add subsection "2.3 Conceptualization of the groundwater-surface water interactions" to illustrate our conceptual model of the study site, which can be depicted with a slightly modified version of Figure 8 (see comment RC1-4).

RC2-5.** Along the same lines as the two previous points, Section 5 is a bit confusing. There are completely new results (e.g., Table 3, Figure 7) first reported on in this section. Conversely, there are not a lot of literature references (none in subsection 5.1, and only 1 literature reference, as far as I can see, in subsection 5.2). So, a lot of the text listed under the "5 - Discussion" header does not really read like a typical

discussion section, in the sense that there is very little confrontation of the present study results with the existing literature. The authors should rectify that as much as possible.

Answer: Done. In the proposed new structure of the manuscript, Table 3 and Figure 7 now appear in the "4 Results" section. Furthermore, to confront our results with existing literature, we suggest providing the following material for each sub-section:

5.1 Local flood-water marked groundwater

Comparison of the isotopic signature of groundwater (δ_G) with the amount-average isotopic signature of precipitations in the south of Quebec (Canada). Such data is available from the GNIP database.

We propose to add the following material:

> *"The estimated isotopic signature of δ_G is more depleted than the St-Bruno amount weighted mean of δ_P (-10.2‰ for $\delta^{18}O$ and -68‰ for δ^2H; calculated from the IRRES database for the year 2016). The latter compares well with the GNIP database long-term Ottawa amount-weighted mean (-10.9‰ for $\delta^{18}O$ and -75‰ for δ^2H) (IAEA/WMO, 2018)."*

5.2 Importance of flood-water inputs in the water balance partition

Falcone (2007) studied the hydrological processes influencing the water balance of lakes in the Peace-Athabasca Delta, Alberta (Canada) using water isotope tracers. They reported that flooded lakes were replenished at 88% in average, whereas the snowmelt-dominated lakes (i.e., not flooded) were replenished at only 31% in average.

We propose to add the following material at L448:

> *"Total flood-water inputs summed at $4.82x10^6m^3$, which is nearly equal to the lake initial volume (i.e., $4.70x10^6m^3$). Similar results were obtained by*

Falcone (2007) who studied the hydrological processes influencing the water balance of lakes in the Peace-Athabasca Delta, Alberta (Canada) using water isotope tracers. They reported that the springtime freshet (in 2003) did replenish the flooded lakes from 68% to $> 100\%$ (88% in average)".

5.3 Resilience of Lake A to surface water pollution

The resilience of kettle lakes in Quebec (Canada) was studied by Arnoux et al. (2017) and this data could be added to Figure 9 for a comparative purpose. A discussion addressing the similitudes and differences between the two datasets (i.e., Arnoux et al. (2017) vs this study) is relevant.

We propose to add the following material (in replacement of L489-493):

"Arnoux et al. (2017) suggested that lakes with G-index $> 50\%$ and $t_f < 5$ years are considered sensitive to groundwater changes, but resilient to surface water pollution. From all the kettle lakes (n = 21) studied by Arnoux et al. (2017), $> 25\%$ were also found to have a G-index $< 50\%$ and a $t_f < 1$ year and were thus characterized as highly sensitive to groundwater quantity and quality changes. Concerning Lake A, all studied scenarios (i.e., reference scenarios A and B and the sensitivity analysis) also yielded to a high sensitivity to groundwater changes. As opposed to the kettle lakes studied by Arnoux et al. (2017), Lake A is located in a floodplain and the flood-water inputs were demonstrated to be highly important over the annual water budget due to a prolonged contribution from flood-water bank storage. Hence, a change in the intensity and/or duration of the yearly recurrent flood events can impact the replenishment of the aquifer (i.e., bank storage) and result in a groundwater quantity and/or quality change."

RC2-6a. ** Subsection 5.3 is a bit confusing. The authors provided a list of physical water quality parameters + ions earlier in their manuscript. Based on their introduction, I expected those physical water quality parameters + ions to be used to support the "surface water pollution" aspects of the manuscript. However, in subsection 5.3, there is no reference to those parameters/ions, and the assessment of resilience to water pollution is solely based on mean flushing time. Why were the parameters/ions described earlier not used?

Answer: Clarification. It was deemed preferable not to discuss the physico-chemical parameters and the major ion data. This decision was made in order to limit the manuscript length. However, we agree that section "5.3 Resilience to surface water pollution" could benefit from an additional discussion concerning the geochemical data. We suggest that the geochemical signature of Lake A is compared to the one of Lake DM, Lake B and regional groundwater (i.e., observed at piezometers upstream of Lake B). Below is the proposed additional figure (Fig. 4 submitted with this response) and interpretation to add to section "4.1 Water fluxes and isotopic framework":

"Water samples were additionally collected at the surface and at various depths within Lake A (n = 23) and at Lake DM (n = 1) during the study period and analyzed for major ions, as detailed in section 3.2. The geochemical facies of Lake A and Lake DM samples are illustrated in Figure 5 by the means of a Piper diagram. Both Lake A and flood-water were found to be Ca-HCO_3 types, which is typical for precipitation- and snowmelt-dominated waters (Clark, 2015). The geochemistry of Lake A is relatively constant throughout the year and confirms depth-wise homogeneity. Water samples were also collected for comparison at the surface and depth of Lake B (n = 42) and at observation well Z16 (n = 11), which is upstream of Lake B and, thus, representative of the local groundwater contributing to the latter (Ageos, 2016). The geochemistry of Lake B is significantly distinct from Lake A and appears to be influenced by

regional groundwater of Na-Cl water type."

Also, we propose to add the following material to section "5.3 Resilience of Lake A to surface water pollution" (at L509):

> *"Considering the Ca-HCO_3 water type of Lake A (see section 4.1) and the importance of the flood-water inputs to the annual lake water budget (see sections 5.1 and 5.2), the flood-water contribution is likely to dampen intra-annual geochemical variations at Lake A and is controlling the low-mineralization levels compared to the neighboring lake (i.e., Lake B). If a reduction in the flood-water inputs was to occur, the geochemistry of Lake A could potentially shift towards that of Lake B. In such a case, an increase of the salinity and in the concentration of Na^+, Ca^{2+}, SO_4^{2+} and Cl^- would be expected for Lake A.*

Note that this issue was also highlighted by Reviewer 2 (see SC1-12c).

RC2-6b. And is it adequate to use the mean flushing time as a proxy measure for a lake's resilience to "all" surface water pollution, regardless of the reactivity/sorption coefficients of the chemical determinants under consideration? This last question may be out of scope for the present manuscript, but a clarification sentence would help manage readers' expectations.

Answer: Clarification. Reviewer 2 is correct; the fate of the contaminant is also to be considered when assessing for the sensitivity/resilience of a lake to a specific surface water pollution. In the submitted version of the manuscript, we simply aimed at demonstrating a broader scenario by depicting the mean flushing time by groundwater, i.e., a key parameter for the resilience to surface water pollution. This reflects the global sensitivity of a water body and is to be adapted for each specific

contaminant. That being said, a brief addition to the discussion could be helpful. Below is the proposed additional material:

> *"Initially proposed by Arnoux et al. (2017), this interpretation framework allows unraveling the response time of a lake to changes in groundwater and/or surface water quantity and/or quality. It depicts a general case, applicable to various surface water pollution, regardless of the fate of the contaminants. Hence, care should be taken when interpreting the sensitivity to contaminants which are subject to attenuation processes, such as degradation and sorption."*

RC2-7.** The first sentence of the conclusion states reiterates that the "goal" of the present study was to "develop a volume-dependent transient isotopic mass balance model, assuming well-mixed conditions, in order to better understand the dynamics of the hydrological processes at a flood-affected lake in southern Canada". As commented upon above, I find this to be rather vague. After reading through the details of the manuscript, it seems like the authors specifically want to address questions related to the relative importance of groundwater for Lake A on an aggregated annual scale as well as through different seasonal/wetness conditions (what they refer to as temporal variability of hydrological processes). The authors also dedicated a fair amount of time/manuscript space to discuss many different elements, e.g.: the peculiarities of lake dynamics under flooding conditions, uncertainties associated with their isotope mass balance model (those uncertainties are multiple in nature, i.e., input data uncertainty, structural data uncertainty, output data uncertainty, even maybe model parameter uncertainty), and the application of pollution resilience assessment framework. It is quite difficult, from the whole manuscript, to figure out which of those elements are primary versus secondary targets/goals/objectives of the manuscript and how they relate (or not) to one another. I think that there is a nice science story in the manuscript, and I hope the authors will see my comments as

suggestions for strengthening it and making it interesting to the broad readership of HESS.

Answer: Done. We made an effort at addressing this issue based on the comments and suggestions above. See response to comment RC2-2 and RC2-4 for clarifications concerning the general and specific objectives and a proposed structure for the revised manuscript.

* SPECIFIC COMMENTS ABOUT SOME TEXT SECTIONS OR FIGURES

See “sticky notes” and yellow highlights in the pdf proofs

Answer: See below.

* TYPOS AND EDITORIAL SUGGESTIONS

See “sticky notes” and yellow highlights in the pdf proofs

Answer: See below.

RC2-8. L24: Refer to “Lake DM”. What is this? Not previously defined in the abstract

Answer: Done. Reviewer 2 is correct; it must be defined first. It should be written “Lake Deux-Montagnes (DM)”. This needs to be corrected.

RC2-9. L36-37: Refer to “Lerner and Harris, 2009;Cunha et al.,2016;Scanlon et al., 2005”. Space missing

Answer: Done. We used the EndNote® Output Style File from Copernicus (downloaded from https://www.hydrology-and-earth-system-sciences.net). We corrected the downloaded referencing style by changing the multiple citation separator to ‘; ’ (i.e., semi-colon and space). All the references were automatically updated.

RC2-10. L46: Spaces missing in-between successive in-text citations. That tends to

happen throughout the text and needs to be rectified

Answer: Done. See response to comment RC2-9 (above).

RC2-11. L56: Refer to “long”. Do the authors mean "long" or "wide:?

Answer: Done. We meant 1 km “wide” area. This is to be corrected in the manuscript.

RC2-12. L59: Refer to “connectivity”. Connectivity between what and what?

Answer: Done. We meant the “hydraulic connectivity between Lake A and Lake DM”. This needs to be specified.

RC2-13. L89: What does "it" refer to, here?

Answer: Done. We refer to S1. This needs to be specified.

RC2-14. L96: Refer to “(Deux-Montagnes)”. This should probably have been specified earlier, i.e., the first time that "Lake DM" is mentioned in this section (see previous page)

Answer: Done. Reviewer 2 is correct. It needs to be specified at L91.

RC2-15. L97: “...drains via the St. Lawrence River. . .” By using the term "via", do the authors mean "to" or "toward" the St. Lawrence River?

Answer: Done. We meant “to”.

RC2-16. L99-100: Refer to ”. . .it is likely that no or very limited subsurface hydraulic connection between Lake A and Lake DM exist.” The authors likely need to expand on this hypothesis a bit. Has this been verified in the field, or is it an assumption/hypothesis solely based on surficial deposits information?

Answer: Done and clarifications. Lake A and Lake B were created by the sand dredging activities. This sand deposit was described by Ageos (2010) as a buried valley, which extends in the NE-SW direction and was carved into the Champlain Sea clay. We propose to add a new figure (see Fig. 2 submitted with this response) and the following text to L97:

> *"While alluvial sands were mapped in the area between Lake A and Lake DM (see Figure 1b), stratigraphic data (i.e., well logs) confirms that only a thin layer (few centimeters to roughly 2 meters) of alluvial sands are deposited on top the clayey sediments in the area between Lake A and Lake DM (see Figure 1d)."*

RC2-17. L151: Refer to ". . . August 17,2017. . ." Space missing.

Answer: Done. Indeed, there is a space missing. Thank you.

RC2-18. L153: Physico-chemical parameters and ions do not seem to have been used at all by the authors, i.e., they are not presented in any result table or figure. Why are the sampling procedures related to them presented here, then?

Answer: See response to comment RC2-6a and RC2-6b.

RC2-19. L164: Refer to "Stable isotopes of water". Oxygen and hydrogen.

Answer: Done. We are grateful to Reviewer 2 for pointing that out. It is indeed more appropriate to use "stable isotopes of oxygen and hydrogen". This also needs to be corrected at L304 (see comment RC2-23b).

RC2-20. L271: There seem to be a lot of "results" that are listed in section 3, which most readers would equate to a Methods section (and not a results section). I would

suggest that the authors try to reorganize their text a bit, so that section 3 only focuses on methods while section 4 summarizes results

Answer: See response to comment RC2-6a and RC2-6b.

RC2-21. L281: Refer to "are". Grammar issue. Subject singular subject, verb plural

Answer: Done. It needs to be corrected to "is".

RC2-22. L282: Refer to "They". Flood-water samples?

Answer: Done. We must specify "The flood-water samples" instead of "They".

RC2-23a. L304: Refer to "Deciphering surface and groundwater inputs". Was that a specific research objective/question for the present study?

Answer: Done. We propose to merge the subsection "Deciphering surface and groundwater inputs" with the revised subsection "4.1 Water fluxes and isotopic framework". We believe that it can facilitate the reading as observations in both Figure 3 and Figure 4 are complementary.

RC2-23b. Refer to "stable isotopes of water". I know that this is a phrase that is used a lot (including by myself, sometimes, mistakingly) but I suggest that the authors rephrase it, as often as is appropriate, in their manuscript. Technically, water does not have any isotopes, but oxygen and hydrogen do.

Answer: Done. See response to comment RC2-19.

RC2-24. L322: Refer to ". . .isotopic composition Lake A. . .". Change to ". . .isotopic composition of Lake A. . ."

Answer: Done. Thank you.

RC2-25. L329: Refer to "Quantification of flood-water inputs into Lake A". Is that

another specific research objective/question in the present study?

Answer: Done. The importance of the flood-water inputs on the water budget is in fact the main objective of our study. See the response to comment RC2-7.

RC2-26. L335: Refer to "...and daily net...". Change to "... and the daily net...".

Answer: Done. Thank you.

RC2-27. L340: Refer to "On early August..." Change to "In early August..."

Answer: Done. Thank you.

RC2-28. L385: Refer to "Sensitivity analysis". Why was this done and how novel (i.e., different from what others have done) is this? Is that another specific research question/objective targeted by the present study?

Answer: Clarifications. The sensitivity analysis was not a specific objective, but it was needed to grasp the relative impact of the input parameter's uncertainties on the model outputs. In order words, our objective was to assess the reliability of the model outputs against a range of possible input values. As the model outputs remained comparable to the reference scenario, we concluded that the model was representative of the local hydrological processes.

In order to limit the length of the manuscript, we propose to move Table 2 to the "Supplementary material" section. Note that the results of the sensitivity analysis are also depicted in Figure 7 and Figure 9.

RC2-29. L411: Refer to "Negligible". Change to "A negligible".

Answer: Done. Thank you.

RC2-30. L413: Refer to "...the value...". Change to "...the values..."

Answer: Done. Thank you.

RC2-31. L416: Refer to "...only small...". Change to "...only a small..."

Answer: Done. Thank you.

RC2-32. L420: Refer to "Importance of groundwater on the annual lake budget". So the reader should assume that quantifying this was a major goal of the present study?

Answer: Clarifications. The main objective of the study was to evaluate the importance of flood-water, relatively to the groundwater inputs, on the annual lake budget. Please see response to comment RC2-7 for the reformulation of the general and specific objectives of this study. To avoid any confusion regarding the objectives, we proposed a modification to the structure of the manuscript (see response to RC2-4).

RC2-33. L438: Refer to "Temporal variability of the hydrological processes". Specific research objective of this study?

Answer: Clarifications. We consider that this a specific objective of the study. We think it is important to underline the temporal variability of the hydrological processes, because the flood events generally occur during a specific time of the year.

RC2-34. L464: Refer to "...Flood-water...". Change to "...flood-water..."

Answer: Done. Thank you.

RC2-35. L469: Refer to "...that water quality...". Change to "...that the water quality..."

Answer: Done. Thank you.

RC2-36. L483: Refer to "Resilience". Since the word resilience can have very different meaning in different sub-fields or sub-disciplines of ecology, hydrology and

ecohydrology, I strongly suggest that the authors provide their adopted definition for that term.

Answer: Done. We are grateful to Reviewer 2 for this suggestion. We propose to add the following material to L484:

> *"Resilience of a system has been defined as its capacity to cope with perturbations (i.e., internal and/or external changes) while maintain its state (Cumming et al., 2005). In the case of a lake, perturbations can manifest as a change in the water quantity and quality contributing to the water balance."*

RC2-37. L495: About the x-axis label: should we read tG or tf? I am a bit confused...

Answer: Done. Thank you. This was also pointed out by the other reviewers. Indeed, it needs to be corrected to t_f (the mean flushing time by groundwater).

RC2-38. L499: Refer to "Arnoux et al, 2017a". This likely warrants more explanation in the text, so that the readers can get a good idea of where that representation/framework is coming from and what its underlying rationale is without having to go back to the 2017 paper.

Answer: Clarifications. Arnoux et al. (2017) performed isotopic mass balances over of 21 kettle lakes in Quebec (Canada) and speculated about their response to a perturbation by comparing the G-index and t_f. Considering these two indices, they proposed an interpretative framework to discuss the resilience of the lakes to surface water pollution, depicted on a plot of G-Index vs $1/t_f$, as we did in Figure 9.

We suggest adding a description of the interpretative framework developed by Arnoux et al. (2017) at L488 and to compare our results to the ones of Arnoux et al. (2017) in Figure 9 and discuss the similarities/differences and implications (see response to comment RC2-5 for the proposed additional material).

RC2-39. L500-509: This paragraph comes a bit out of nowhere. It should be better linked with previous text, as well as specific research questions or objectives (which are currently missing from the manuscript)

Answer: Done. We propose to add the following material at L500:

> *"Considering the above, it is possible to speculate about the potential future impacts of climate change on Lake A."*

Additionally, it is relevant to add a discussion concerning the impact of the flood-water inputs on the geochemistry of Lake A (see response to comment RC2-6a).

RC2-40. Figure B1: The caption refers to blue hollow symbols and a solid blue line by my version of the manuscript includes a black and white figure, not a color figure.

Answer: Done. Thank you. Indeed, the caption needs to be consistent with the figure. It is to be corrected to "black".

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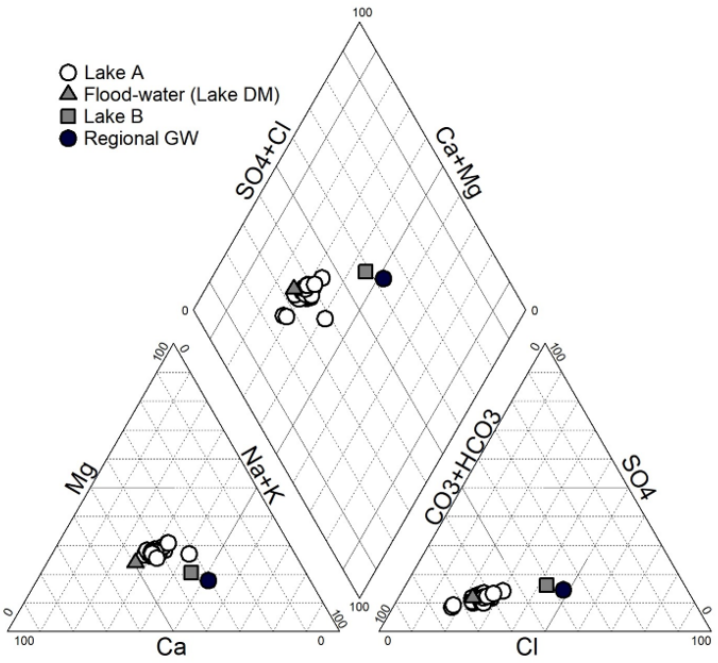

Fig. 1. Geochemical signature of Lake A, Lake B, flood-water and the regional groundwater (GW).

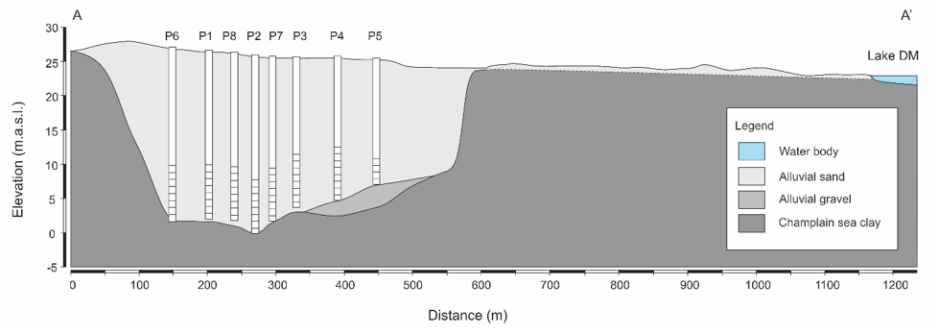

Fig. 2. Schematic representation of the A-A' cross-section.