

Reply to referee 1

We would like to thank you for your constructive comments and feedback on this manuscript. We think that the suggested revisions based on the Referee's comments will certainly improve the article. Please find our responses (in blue) to the main points raised (shown in black) below.

General comments

1. You should discuss the sensitivity of the glacier melt contribution to your ice albedo value and glacier-melt initiation threshold value. Since this is the main result, there needs to be some quantitative uncertainty or sensitivity analysis performed and reported.

→ Thank you for your suggestion and we agree on the value of discussing the sensitivity of glacier melt contribution to the ice albedo values in the result section 3.1 (Glacier module performance). We will discuss the sensitivity of glacier mass balance and glacier area reduction with respect to the different albedo values tested and reported in Figure 2. It is important to note that, within the simple dynamic glacier module of the semi-distributed hydrological model we used, albedo embeds multiple processes that influence melt dynamics that cannot be explicitly represented as in other models. These processes include factors such as increased melt rates due to accelerated fragmentation or to debris-covered ice. Consequently, albedo encompasses various mechanisms affecting glacier melting which the model shows a strong sensitivity to.

2. The discussion section needs to be more impactful. You should expand on the implications of your findings, especially as they relate to water availability and needs in the Adige. What are the water management implications? What are the consequences of lower glacial melt contributions to streamflow in the future? How might this change with predicted temperature and precipitation shifts in the region? You can also expand on how your results in the Adige fit into regional patterns, or how they compare to other similar basins. Right now, the discussion reads somewhat as an extension and summary of the results, but it should highlight the impact of the results.

→ Thank you for raising this important point and we agree this suggestion can enhance the discussion impact. We are going to improve the discussion section to highlight the water management implications already experienced in the presented droughts (i.e. Avanzi et al., 2024), as well as providing an outlook on future conditions and potential consequences in relation to the "peak water glacier contribution" concept, as highlighted in the following comment n.3.

Avanzi, F., Munerol, F., Milelli, M., Gabellani, S., Massari, C., Giroto, M., Cremonese, E., Galvagno, M., Bruno, G., Morra di Cella, U., Rossi, L., Altamura, M., Ferraris, L., 2024. Winter snow deficit was a harbinger of summer 2022 socio-hydrologic drought in the Po Basin, Italy. *Commun. Earth Environ.* 5, 1–12. <https://doi.org/10.1038/s43247-024-01222-z>

3. It might be helpful if you framed part of your analysis/ discussion around distinct stages of glacier runoff. The fact that 2022 had lower melt than 2003 despite similar warm temperatures is a possible indication that the basin may have passed its “peak water” or peak glacier melt runoff (Huss and Hock, 2018). Using this terminology or a different, distinct glacier stage framework might provide a clearer lead-in to a discussion on the broader implications of your results.
 - Huss, M., Hock, R. Global-scale hydrological response to future glacier mass loss. *Nature Clim Change* 8, 135–140 (2018). <https://doi.org/10.1038/s41558-017-0049-x>

→ Thanks, and we can introduce and refer to the peak water concept when discussing the overall results and the implications for future water management.

Line-by-line:

4. Lines 23-24: In your results section, you mention KGE values between 0.4 and 0.86 (lines 241-242). There seems to be a mismatch between what is reported in the abstract and what is reported in the results.

→ Thanks for pointing this out. The reported values are correct, but we see the need to clarify that the values in lines 23-24 refer to the overall basin in the Bronzolo closing station, while the values in lines 241-242 refer to the single subbasin units.

5. All sub-basins should be defined (perhaps in Figure 1), and you should explain what information about each sub-basin is available in your supplementary table. You reference basin numbers and some sub-basin names, but it is not very clear where they are located.

→ Thanks and we see the need to add the sub-basin number in Figure 1 so to help correctly interpret each result to their spatial location creating a clear link with the info reported in the supplementary table.

6. Line 140-141: What is the threshold value? Also, is it a threshold of depth (mm of SWE) or a percentage of area? This seems to be a very important parameter, but it is not described in much detail.

→ The minimum SWE value below which glacier can start melting is 5 mm and is fixed according to (table 1 in Zaramella et al., 2019). We can cite the paper from Zaramella so to provide further information:

Zaramella, M., Borga, M., Zocatelli, D., and Carturan, L.: TOPMELT 1.0: a topography-based distribution function approach to snowmelt simulation for hydrological modelling at basin scale, *Geosci. Model Dev.*, 12, 5251–5265, <https://doi.org/10.5194/gmd-12-5251-2019>, 2019.

7. Figure 4: Remove light-colored boxes around panels.

→ we see there are some visualization problems depending on the pdf visualization software and we are going to fix it.

8. Line 285: $r=0.47$ is not a strong correlation; it is a modest correlation.

→ thanks for pointing it out and we are going to replace “strong” with “modest”.

9. Line 307: You need to be more specific here. This year was the lowest for each of the 14 subbasins or overall, they have the lowest average SWE?

→ thank you and we see the need to make this sentence clearer. We meant that the 14 subbasins that showed the lowest decrease in SWE during summer 2003 were also those that showed the lowest SWE in the climatological mean. We will modify it accordingly.

10. Section 3.3.3 should go in the discussion section and needs more description on the importance of glacial retreat to water resource availability.

→ thank you for your comment and based on your and the comments from reviewer n2 we see the need to better emphasize the importance of this analysis. Our proposal is to keep section 3.3.3 as part of the results, replacing current table 1 with a figure that can make this section more prominent while also adding further reference to it in the discussion section.