Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., referee comment RC1
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Review of hess-2021-512

Bettina Schaefli (Referee)

Referee comment on "Quantifying the glacial meltwater contribution to streams in mountainous regions using highly resolved stable water isotope measurements" by Philipp Wanner et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-512-RC1, 2021

This paper proposes to quantify the contribution of ice melt to total streamflow in three highly glaciated catchments in the central Swiss Alps with the help of astable isotopes of water. The aim is to come up with results that are more reliable than previous modelling-based results and with recommendations for future sampling campaigns.

I cannot recommend the paper for publication because some fundamental hydrological process knowledge is ignored. The obtained results are not plausible (glacier melt contribution of between 80% and 95% to total streamflow during August in catchments with only between 6 and 28% glacier cover). One key result is summarized in Figure 8, which shows glacier melt in Mio m^3 against glacier area. For the smallest glacier investigated, this result indicates meltwater production of $4*10^6$ m^3 on an area of 0.3 km^2, which corresponds to a melt water production of $4*10^6$ $m^3/0.3*10^6$ m^2 = 13.3 m of melt water production over the glacier area. For the largest glacier, it is $18*10^6$ $m^3/6.8*10^6$ m^2 = 2.7 m of meltwater production. The first value is impossible, the last value is in the order of observed summer mass balances in Switzerland in 2019 (see Figure 1 one in the attached complete review).

The reasons for the erroneous estimates are certainly related to the wrong assumption that streamflow during summer is only composed of glacier melt and of rainfall. In reality, an important part of streamflow is groundwater (baseflow) released by the hillslopes; the isotopic values of groundwater are strongly influenced by snow melt and thus close to the values of glacier melt (see below). Accordingly, the separation into glacier melt and not-glacier melt is impossible with the help of isotopes alone. EC values could help separating ground water from non-groundwater input but this would require values for groundwater and values for ice melt at the glacier snout (which was already in contact with the ground).

See my full review in the attached pdf.

Please also note the supplement to this comment:
https://hess.copernicus.org/preprints/hess-2021-512/hess-2021-512-RC1-supplement.pdf