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Comment on hess-2021-377

Anonymous Referee #1

Referee comment on "The Spatiotemporal Regime of Glacier Runoff in Oases Indicates the Potential Climatic Risk in Dryland Areas of China" by Xuejing Leng et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-377-RC1>, 2021

Review HESS **The spatiotemporal regime of glacier runoff in oases indicates the potential climatic risk in dryland areas of China**

This manuscript calculates timeseries of glacier runoff for the dryland areas of China for the period 1961 until 2015 using the APHRODITE gridded precipitation and temperature products. These estimates of glacier runoff are used to indicate the amount of glacier meltwater that comes from the imbalance and balance component of glacier runoff (referred to as meltwater runoff and delayed runoff, respectively, in the manuscript) and to analyze trends. In the discussion section the amount of glacier runoff is compared with some estimates of the agricultural, industrial and municipal water consumption. All of the analyses are done for 22 basins in the northwestern part of China.

Although the title of this study sounds interesting and could potentially be of interest for HESS, I found this first impression not reflected in the content of the rest of the manuscript. First of all, the poor writing and unfinished or wrong sentence structures make it at many places impossible to understand what actually has been done. Regardless of the writing, the methods are described in a very unsystematic way and many details are missing. Furthermore, I had troubles identifying the added value of this study. The study uses several different existing datasets to calculate annual glacier runoff, which is according to the study a novelty compared to the multi-year mean geodetic mass balances. However, it does not become clear which question(s) can be answered with these annual glacier runoff estimates. A clear link to other terms in the water balance of these oases regions is missing, or a discussion how water from the glaciers reaches the agricultural areas. I even doubt the usefulness of calculating trends if changes in glacier extent are not considered. Overall, I cannot recommend publication of this study. Please find below a few more comments.

P2: 'Under current climatic conditions, warming causes glaciers to melt and sea level to rise, creating a negative feedback between the two' -- what is the negative feedback here?

P3: 'Semi-distributed hydrological models semi-quantitatively calculated the proportion of meltwater runoff to total runoff without time series' -- what is meant with 'without time series'?

P4: 'Dataset of spatial distribution of degree day factors for glaciers' -- since this dataset is so central for the calculations in this study, just giving a link to this data is not acceptable

P5: The table shows the area of the oases in each watershed. Apart from expecting here instead the relative area of OAA and glacier cover, the amount of rain in mm does not give a lot of information on the importance of glacier runoff. Why is glacier runoff not calculated as mm/y?

P7-15 Methods:

A whole page is used to describe different studies and data sources of geodetic mass balances, first describing that two datasets will be compared (Brun and Shean), to later read only the 'Shean estimation' is used.

The resolution is 100 m. What does this mean? How does the DDF vary in space? Are the PDD or PDDm calculated for each glacier, for each 100 m, for each basin?

How was the maximum rainfall height determined?

From the description in the manuscript it is also unclear how the precipitation gradient was optimized. Was the ablation calculated based on the same period as the Shean mass balance estimation? And what is 'H', the mean elevation of the glacier? In the current formula (equation 4), the elevation between Hmax and Hmap are taken twice into account? Or did I understand something wrong? Should it not be (- delta H)? Why were the vertical gradients interpolated if they are already calculated for each individual glacier?

Like in other parts of the paper, also here discussion parts are mixed up with the methods part and it is confusing to read again about the precipitation gradients in section 2.3.2.

Regarding the uncertainty analyses, what is meant with 'the PG of each single glacier around the DAC was obtained with geographical simulation'? In a few paragraphs before I read that PG was obtained by fitting the accumulation to the geodetic mass balance and estimated ablation? And why is only the uncertainty in the Shean mass balance estimation considered? What is the uncertainty in the DDF? These can have a large effect also on the accumulation estimates.

For the calculation of glacier runoff and consequently the trend analyses, I do not understand what is meant with the 100 m resolution of this study and how changing glacier area is considered. Are precipitation and temperature calculated for fixed grid cells containing the glacier? Which of the parameters are changing over time to calculate a trend in the glacier runoff? Changes in P and T can affect the total glacier runoff and the partitioning between balanced and imbalanced contributions, but also the changes in glacier extent play a role for the amount of glacier runoff.

P15: 'The creeks of the Kriya Rivers basin were the most unique, with 93.67% of the components (glacier runoff) coming from delayed runoff; therefore, more attention should be paid to glacier disasters in this basin. What is meant here?

Why is 3.2 a results section? It rather discusses the results? the 3.2 on P18, there is also a 3.2 on P23.

What is the point that the study tries to make in Section 4.1 and 4.2? From the methods section the calculation of the precipitation gradient was already unclear, but the discussion section does not clarify any of these concerns. Hmap and Href are the same? Could the 'believing' in one or two maximum rainfall heights not be demonstrated here?

Section 4.3 does in my point of view not add anything to the study.

Regarding section 4.4, it is described that oases in the DAC rely most on glacier runoff and that it maintains soil moisture, vegetation growth and groundwater replenishment. However, without comparing glacier runoff to other sources of water and without describing the pathways of glacier runoff (how does glacier melt become soil moisture?), such conclusions cannot be drawn.

P33: 'For example, due to increased temperature and reduced glacier runoff, California, in the United States, experienced a severe drought from 2011 to 2015 where hydroelectric power decreased by two-thirds' -- I think such a statement requires a reference. Moreover, a lack of precipitation and snowmelt and increased evaporation caused a severe drought, rather than the small 'reduced glacier runoff' contribution.

P33: 'In the future, glacier runoff will reach its peak when glacier tourism disappears' -- What is the connection between these two processes?

P34: The linear regression is only introduced in the conclusion (I could not find it elsewhere in the manuscript). Apart from that, how does the study deal with the non-linear change in glacier runoff (peakwater)?

P34: Nothing that is mentioned at point three in the conclusion I can find in the results section. Where do these conclusions come from?