

Rebuttal 'Geometric dependency of Tibetan lakes on glacial runoff'

We received many constructive comments from the reviewers on the first version of our manuscript as submitted to the journal of Hydrology and Earth System Sciences. In this rebuttal we first summarize the major changes that we implemented in the manuscript before resubmitting. After that we list in detail all comments of the two reviewers followed by our (re)action. All our actions are in italics.

Major changes

We added two parts to the discussion chapter:

- 4.1 The hydrological interpretation of the geometric dependency on glacial runoff*
- 4.2 Details on computing the geometric dependency of lakes on glacial runoff*
 - 4.2.1 Sensitivity of the results*
 - 4.2.2 Manually calculating the area of a lake sub-catchment using ArcHydro*
 - 4.2.3 Dividing the Tibetan plateau into parts for speeding up computations*

Referee #1

How can hydrologists use the R_D and R_U ? A cynical hydrologist may just say this is just a ratio between two drainage areas. What is the hydrological meaning? A glacier melts not over its full surface but only over the ablation area and melt is seasonal. Do the rain season and melt season coincide? This needs to be better described in the paper.

We added a paragraph on the hydrological interpretation of the R_D and R_U indicators to the discussion chapter, section 4.1 on page 15.

There is evidence the glaciers are retreating and this may impact the lake levels. On the one hand the melt rate per unit area is increasing and simultaneously the total glacier area is decreasing. The total melt is the product of both and at some point in the future we will have a maximum melt water peak. Globally this estimated to occur around 2070 (Radic and Hock, 2011) and this is essential because that is what will determine the trend in lakes dominated by glacier melt. It is likely that that point has not been reached in Tibet and hence we would suspect an increase in lake levels that are glacier dominated.

We discussed partly in Discussion section.

From the introduction it seems some lake levels are rising and some are falling and this is contradicting. Later it is shown that for Nam Tso lake levels are indeed increasing, but this needs much better discussion and probably also quantification.

We removed the extra information on the modeling of the water balance at Nam Tso in the introduction on page 3.

We wrote on the geometric dependency of Nam Tso on glacial runoff as a case study on page 13 and discussed this lake as well in section 4.1 on page 16.

Can the observed rise in lake levels be explained by the melt of the glaciers draining into it. A simple DDF based assessment could answer this question.

We discussed this in section 4.1 on page 16.

Lakes in Tibet are very complex and many are connect through complicated groundwater systems, many are endorheic, but this is hardly discussed.

We discuss this now in section 4.1 on page 16.

The information content is sometimes a bit low and the paper could be condensed a bit.

We shortened the section on determining Tibetan lake catchments on page 6, where some information was repeated in section 4.3 on page 17. Also the whole text has been revised.

Referee #2

(1) The Intro covers relevant studies, but it is mostly just a list of studies. You should summarize the key findings as relevant for your work. Also, you should develop the motivation for your study based on that. As now, the motivation of your work is weakly described. (You should also include Zhang et al. (2013), GRL, even if just recently published, after your submission).

We removed few references little relevant to make the introduction clear and also added (Zhang et al., 2013) into the introduction section on page 2.

(2) You should write a section about the accuracies/problems/sensitivities with your results. Among the potential sources of problems:

- MODIS water mask

- How reliable is the combination of MODIS water mask and SRTM to define if a lake has an outflow or not? What with narrow channels that are not detected by SRTM?

- How about very flat outlets, where the detection based on SRTM might be randomly dependent of SRTM accuracy?

- How about seasonal variations (no outflow in one season, overflow in another)?

- How sensitive are your results against the deformations in the glacier mask?

We added a paragraph on the sensitivity of our results in the discussion chapter on page 16.

(3) You should make clearer that your results are a theoretical geometrical dependency of lakes on glaciers. Make clearer what processes are neglected compared to a real dependency. E.g. under conditions of heavy evaporation the distance between glacier and lake might be an important factor. Same for losses to groundwater. Sure, there is more.

We added a paragraph on the hydrological interpretation of the R_D and R_U indicators to the discussion chapter, section 4.1 on page 15.

(4) The discussion section is not really a discussion. You just add two minor methodological aspects. What is lacking in the discussion and conclusions is a hydrological discussion, about the hydrological significance and representativeness of your results (e.g. see (3)), and perspectives. What needs to be done to arrive at hydrologically more meaningful results? How could they actually change the picture you give?

See previous two questions

Specific comments:

- 2.1., MODIS land water mask. It became not clear to me what you did, and to what extent you used existing data (checked with GoogleEarth, Landsat, etc.? Did you that?). How do lake seasonality or trends affect the mask?

We mentioned this in the sensitivity analysis of our results on page 16.

- 2.1. Which glacier mask did you use, the new one or the old one. You mention both, and it is not clear which you used.

We made this clear on page 4, removing the extra information of the glacier mask in new version.

- In general, there are some redundancies. Try to remove repetitions throughout.

The whole text has been revised.

- Try to make the figures more readable. Size, resolution, colors.

We increased the resolution of the figure 8, which mapped the geometric dependency of Tibetan lakes on direct glacial runoff.