The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2020-117-AC3, 2020

The Cryosphere Discussions

Interactive comment on "Tracking the impacts of the Aru glacier collapses on downstream lakes" *by* Yanbin Lei et al.

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Received and published: 12 August 2020

General comments: After reading the manuscript, I feel that the title is a bit too specific and does not contain what has been done in this work. I suggest rephrasing the title.

Response: Thank you very much for the constructive comments and suggestions. We will revise the manuscript carefully according to these comments. About the title, we will change it as 'How did the two downstream lakes respond to Aru glacier collapses?'

The hydrological connection is very interesting in my point of view. However, the reasoning of the buffering effect of the Aru Co on the Memar Co is not very convincing. L175, "discharge from Aru Co only accounted for 20-30% of the lake volume increase at Memar Co in the cold season". How is this conclusion made? Simply assume that

the decline in water level completely attributes to outflow? From Lei et al. (2019 GRL), it seems the seasonality of 0.5 m is reasonable for endorheic lakes in the same region. It could be also possible for the Aru Co presenting a 0.5 m annual fluctuation without outflow. Outflow may happen in summer when the recharge is larger. But in cold season, whether outflow happens is questionable. It simply depends on the elevations of the Aru Co and the channel connecting the two lakes. So it needs to be careful when calculating the contribution of outflow of the Aru Co to the rising of the Memar Co by simply comparing the decline of the Aru Co and rising of the Memar Co.

Response: Thanks for raising this question. The hydraulic connection between Aru Co and Memar Co is not the main topic of this study, so we do not want to address this in more detail. The lake level increase in cold season at Memar Co is very interesting and we will analyze this special lake level seasonality in another paper. Yes, the percentage of 20-30% is simply calculated according to lake volume changes of Aru Co and Memar Co during ice covered season. As we have shown in the text, the two lakes are covered by lake ice between December and May. During this cold period, lake level of Aru Co decreased slightly while Memar Co increased dramatically. The decrease in lake storage at Aru Co only accounted for 20-30% of the lake volume increase at Memar Co, so we believe that the lake surplus at Memar Co is not mainly supplied by discharge of Aru Co, but by other source of water discharge, for example groundwater supply. It is true that the seasonal lake level fluctuation is in a range of 0.5 m and we agree that it is questionable to compare the decline of the Aru Co and rising of the Memar Co when the lake does not freeze up.

Another concern is the altimetry data processing, which affects the reconstruction of historical lake levels. Current methodological description is very vague. What are the data sources? How is the water level generated? How is the bias between the two data sets handled? The results relating elevation changes are heavily dependent on the bias of the two data sets.

Response: Thanks for the good suggestions. We will address the processing of altime-

try data in more detail in the revision. ICESat altimetry data, which was processed according to Li et al (2014), was used to examine water level variations between 2003 and 2009. CryoSat-2 data, which was processed according to Xue et al (2018), were used to examine water level variations between 2010 and 2018. Notably, the two datasets are referenced to different ellipsoids and geoid height. The ICESat data contains corrected surface ellipsoidal heights referenced to TOPEX/Poseidon ellipsoid and geoid height referenced to Earth Gravity Model (EGM) 2008; while the CryoSat-2 data are referenced to WGS84 and EGM96 (Song et al., 2015). In order to make the two datasets comparable, lake elevation at Aru Co is compared because the lake is an outflow lake and inter-annual lake level changes are relatively small. As shown in Fig. 5, lake level at Aru Co was in its lowest in May and it is very stable from year to year determined by the outlet. The ICESat derived lake surface elevations of Aru Co were averaged to be 4936.67 m a.s.l. in April during the period 2003-2009 (n=2, Stdev=0.01). The CryoSat-2 derived lake surface elevations of Aru Co were averaged to be 4937.04 m a.s.l. in May during the period 2011-2016 (n=5, Stdev=0.08). This elevation difference of 0.37 m is considered to be the bias of the two datasets at the study area.

Specific comments:

L52: “dramatic increase”, I do not think there is a dramatic increase in precipitation. Before 2014, the increasing of precipitation is not significant, and a plethora of studies debated the reason of lake expansion. Until recent years, the increasing of precipitation is much clear but not dramatic.

Response: This part will be moved to discussion part because another reviewer suggests that it is not closely related to the subject of the study. Precipitation exhibited dramatic inter-annual fluctuations on the interior TP, so the dramatic increase was not obvious at some stations. However, the overall increase in precipitation is very clear in most stations of the interior TP.

L65-69: Do you think the bathymetry have significant change?

Response: The ice avalanches influence lake bathymetry mainly near the collapse fan, not the whole the lake (section 4.1).

L90: How was the snow measured?

Response: The snow was measured by a T200B rain gauge.

L191: “Sential” -> “Sentinel”, please also change it in the caption of Figure 4.

Response: Thanks for pointing out this error.

L192: Figure 3a should be Figure 4a.

Response: Thanks for pointing out this error.

L209-214: How many pairs of level and area are used to build this regression model? Extrapolation based on data of six years could be problematic. This needs to be better explained.

Response: In this study, six pairs of lake level and area are used. Since these data contains the lowest ($\sim$1997) and highest level, the regression model used in this study is reliable.

L217-218: It seems that the satellite data did not capture the sudden rise (pink dotted line) revealed in Figure 5b. Is the pink coded line indicating the reconstruction?

Response: The pink dote line is the satellite altimetry data. The dramatic increase of lake level change occurred during the period between 2016 and 2019. To be honest, the sudden rise in lake level at Memar Co after the Aru-1 collapse can not be captured due to its temporal resolution.

L256-257: The seasonality revealed by satellite data is not very clear due to the course temporal resolution.

Response: We agree with this. Because the lake was also rapidly expanding before the glacier collapse, the lake level seasonality revealed by Cryosat-2 data did not exhibit big

difference before and after the collapse. However, if we compare the average values during the two periods, we can find the considerable difference of lake level change in summer.

Conclusion: I would suggest the authors try to concise the conclusions, right now too many repetitive statements from the results.

Response: Thanks, we will rephrase the conclusion carefully.

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