Response to reviewer's comments (essd-2021-354)

Spatio-temporal evolution of glacial lakes in the Tibetan Plateau over the past 30 years

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Dear reviewer,

Thank you for reviewing our manuscript. We carefully re-evaluate the novelty and originality of our study, especially by comparing with other published studies, i.e. Wang et al. (2020). Actually, novelty of a study is always the first and the most important thing to evaluate before conducting any research. The overall objective of our research project is to reveal the spatio-temporal evolution of glaciers and glacial lakes in Tibetan Plateau and their response to climate change. We intended to use other published glacial lake inventories, but we found that there is a lack of high-resolution multi-temporal inventory of glacial lakes covering the whole Tibetan Plateau after through literature review. There are some inventories have high temporal resolution but only covers small regions, while some other inventories covering larger area of Tibetan Plateau but only from one or two periods (i.e. Wang et al., 2020), see the Introduction and Discussion (5.1 Comparison with other glacial lake datasets) for details. This gap motivates us to spend more than one year to collect data and develop methods to create a new inventory, which we believe is more complete, accurate and higher temporal resolution (covering three periods for the whole Tibetan Plateau).

We provide more evidences and responses to your concerns as follows. We hope you can recheck our study.

Thank you again for reviewing the manuscript.

Best regards,

Xuanmei Fan on behalf of all coauthors

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Reviewer comment 1:
The authors provided a detailed inventory from a large area for a long-time span. Nevertheless, the similarity to the paper Wang et al. (2020) is too high. They discuss the differences/similarities in the chapter Discussion, this is fair. They also applied more accurate data, but according to the comparison with the paper Wang et al. (2020) they did not get a significant difference. The paper is well written, appropriate structure, but they just choose wrong topic. The time difference is too close to the previous paper and climate change can not be seen in the results. If I simplify it little bit, they just confirmed that the study from Wang et al. was well elaborated.

Response 1:

We are thankful to your brief review and kind words on the writing style and structure of our manuscript. To your concern about the similarity of Wang et al. (2020), we provide following discussions to show the difference of our study from Wang et al. (2020):

(1) Wang et al. (2020)'s inventory contains only two years: 1990 and 2018, so the changes of glacial lakes they show are by comparing the imagery of the year of 1990 with 2018 (1990-2018). Our inventory covers three periods: 1990-1999, 2000-2012 and 2013-2019, so it fills in the intermediate data gaps and also requires two more times of mapping work, see Table 2 in the manuscript. The advantage of our inventory will be more evident when one uses it to analyze the changes of glacial lakes to high resolution climate change data. It is commonly known that the average temperature of the Tibetan Plateau shows an increasing trend, but it also has large fluctuations in different years. Inventory with higher temporal resolution can help us to better understand the responses of glacial lakes to climate change. This is also an important direction for our further study.

(2) The data and methods used in our study are different from those of Wang et al. (2020), which leads to the difference in mapping accuracy. We obtained three images by fusing the highest quality Landsat images without cloud cover and

mountain shadows from July to November each year, according to the requirements for glacial lake extraction using the GEE platform. There were 42,833 Landsat images used in total. While Wang et al. (2020) used single-year mapping, 394 and 274 Landsat images to represent 1990 and 2018, respectively.

We avoided any anomalies in the glacial lake extraction (from single-year mapping) due to image quality or unusual climatic conditions. Therefore, our inventory is more complete and also more accurate.

To further prove this point, we randomly selected several regions of the Tibetan Plateau for a sample check of the accuracy and completeness of the glacial lakes from both our inventory and Wang et al. (2020). Please note that in the figures - blue line shows the glacial lake from our inventory, and red is from Wang et al. (2020).

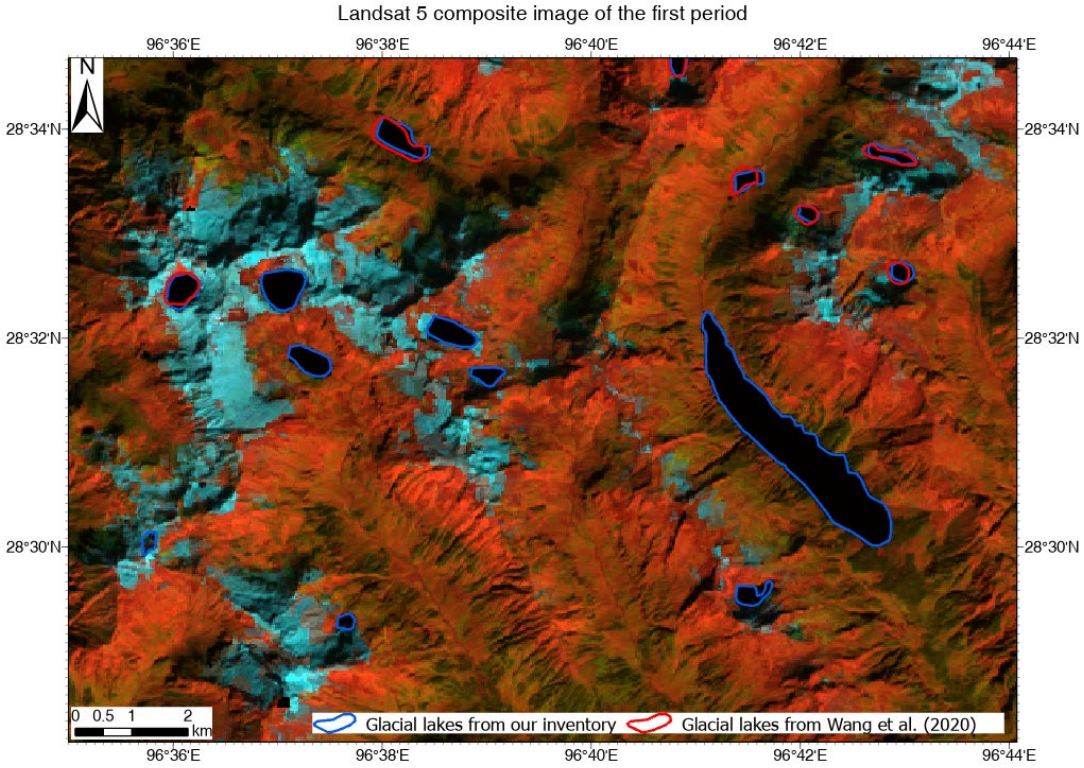

Figure 1. Automatic extraction of glacial lakes using Landsat 5 composite imagery for randomly selected region #1

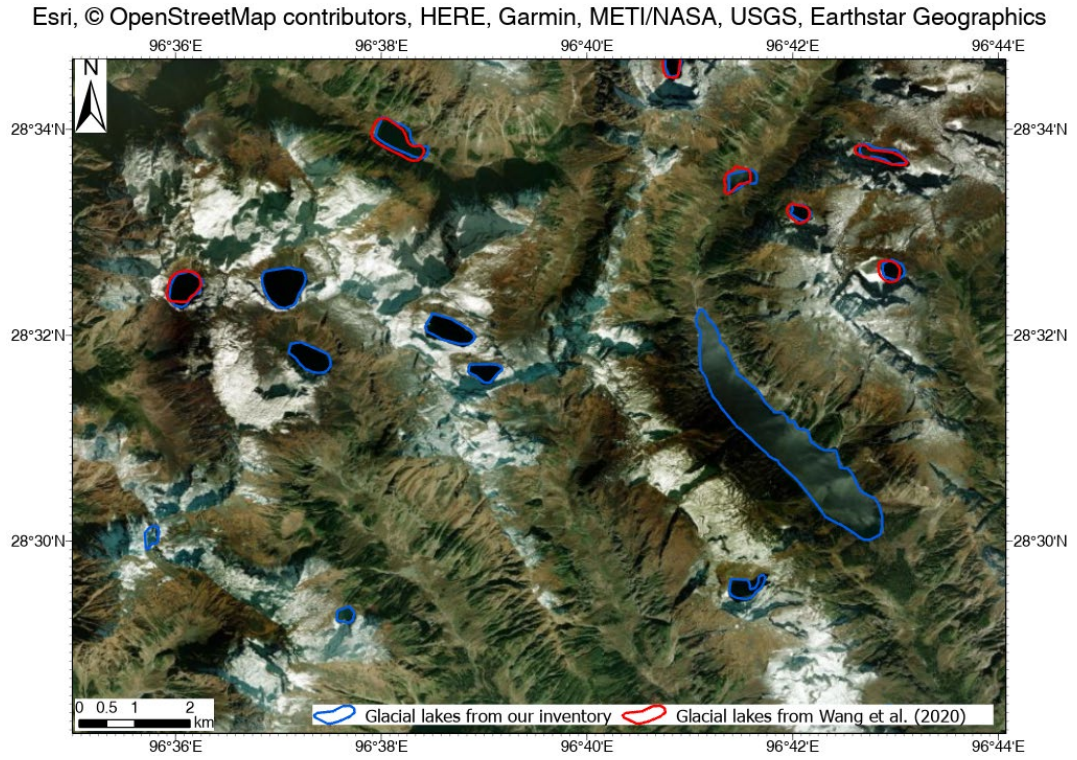

Figure 2. Extracted lakes from Figure 1 overlaid on ESRI online maps

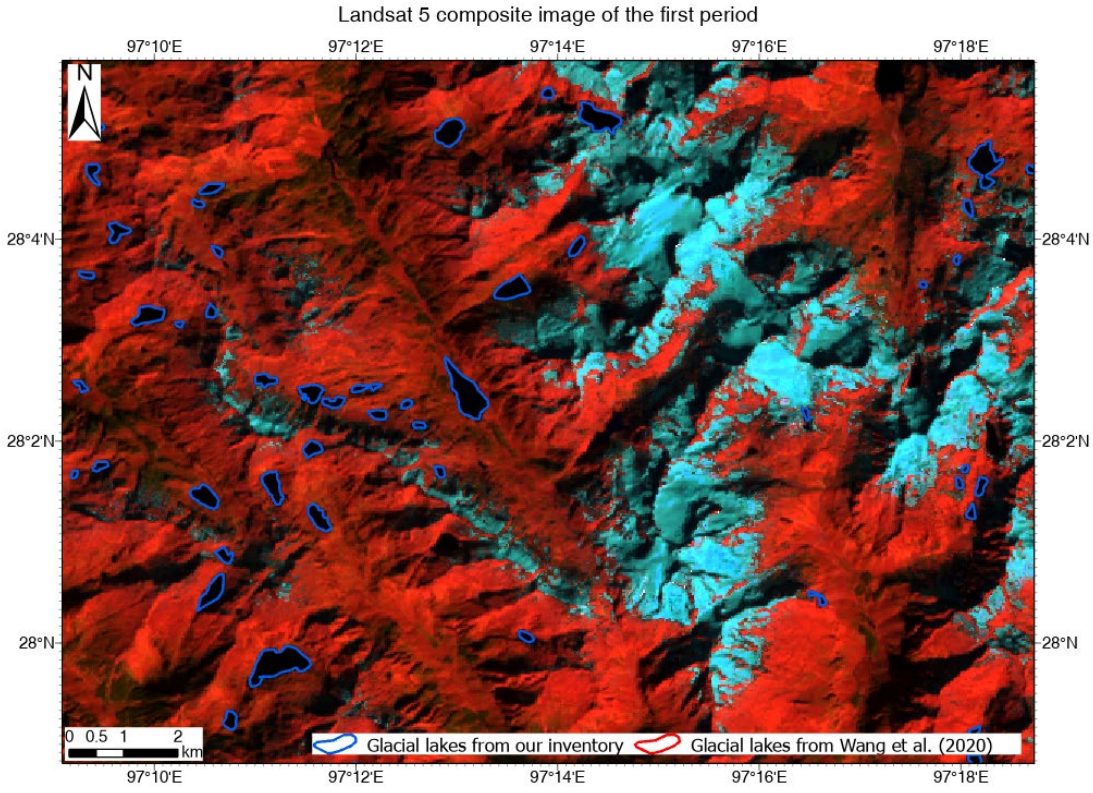

Figure 3. Automatic extraction of glacial lakes using Landsat 5 composite imagery for randomly selected region #2. Note Wang et al (2020)'s inventory did not map any lakes in this region.

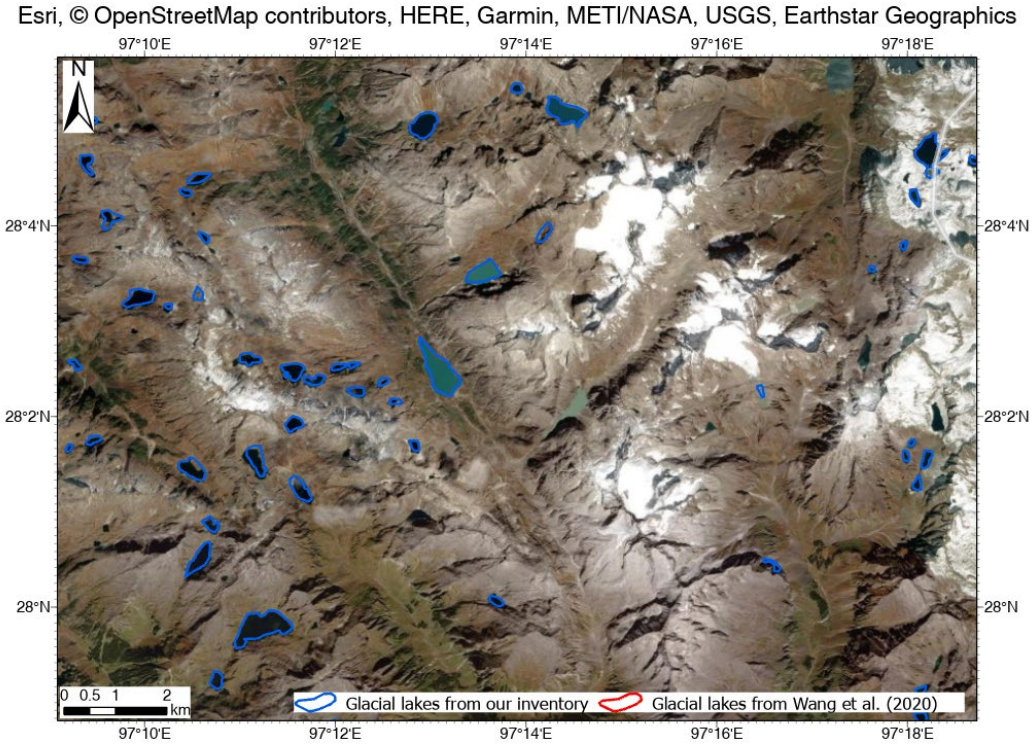

Figure 4. Extracted lakes from Figure 3 overlaid on ESRI online maps. Note Wang et al (2020)'s inventory did not map any lakes in this region.

From above comparisons from randomly selected regions, **we can see that several glacial lakes are missing in Wang et al. (2020).** Thus we have mapped larger number and area of glacial lakes, see the table below and also Table 2 in our manuscript.

Table 1 Number and area of glacial lakes from this study and Wang et al. (2020)

Dataset sources	Time	Number	Area (km^2)
This study	1990-1999	19183	1509.17
	2000-2012	20655	1637.01
	2013-2019	22468	1767.99
Wang et al. (2020)	1990	18025	1349.214
	2018	20250	1579.009

It is worthy mentioning that constrained by lack of yearly available high quality images, a year-by-year inventory of glacial lakes is currently not possible. Our approach, therefore, provides a most updated inventory with the possible inclusion of almost all glacial lakes in the whole Tibetan Plateau. We believe it also provides the

greatest possible demonstration of the dynamic evolution of glacial lakes with higher temporal resolution.

Reviewer comment 2:
The main task for my review was to compare similarities with other papers from this region. I did not provide a standard review, nevertheless one comment I must stress here. What I see as disadvantages of this paper is the limit for "glacial lake" 10 km from a glacier. The wrong idea behind this limit is that "glacial lake" is "glacial" because of its origin (from the glacial action - glacial erosion of valley or glacial accumulation - moraine). It means that he essence of the term is in the origin of the lake, nothing to do with the distance from glacier, source of water in the lake etc.

Response 2:

Thanks for your comment, but we have different opinion on this issue. By definition, "glacial lakes are bodies of water that are influenced by the presence of glaciers. They are commonly divided into two main groups: ice-contact lakes which are characterized by the presence of glacier ice terminating in lake water and distal lakes that are somewhat distant from, but still influenced by, the presence of glaciers and/or ice sheets. Glacial lakes are common features around the margins of glaciers and ice sheets, and often evolve from ice-contact lakes into ice-distal lakes as glaciers and ice sheets margins retreat and become spatially separated from the lake. (S. Fitzsimons, J. Howarth, in Past Glacial Environments (Second Edition), 2018)".

For automatic mapping tens of thousands glacial lakes based on remote sensing imagery, distance from nearest glacier terminus is a commonly used criteria for almost all previous inventories. Manual mapping of glacial lakes for small regions of course can consider more factors and are more accurate, which are not applicable for large regions. As we described in the first paragraph of *Section 3.2*:

"The distance between the glacial lake and its nearest glacier terminus is one of the criteria of identifying a glacial lake. In previous studies, several distance values, such as 2, 3, 5, 10, and 20 km, have been used as the maximum threshold value for glacial

lake identification (Petrov et al., 2017; Veh et al., 2018; Wang et al., 2013b; Zhang et al., 2015). Nie et al. (2017) and Zhang et al. (2015) attributed that a distance of 10 km from the nearest glacier terminus as a reasonable threshold. After comparing the published glacier inventories covering the TP, including the Global Land Ice Measurements from Space (GLIMS) glacier database (Raup et al., 2007), the Randolph Glacier Inventory (RGI) (Arendt et al., 2017; Pfeffer et al., 2014), the Glacier Area Mapping for Discharge from the Asian Mountains (GAMDAM) glacier inventory (Nuimura et al., 2015), and the First and Second Chinese Glacier Inventory (CGI) (only covered the Tibet Autonomous Region of China) (Guo et al., 2015; Shi et al., 2009), and many others (e.g., Jiang et al., 2018; Paul et al., 2013; Raup et al., 2013; Smith et al., 2015), we selected the buffer with a 10 km distance to determine the spatial distribution range of the glacial lakes in this study."

Therefore, after our comprehensive analysis, we chose 10 km as the maximum threshold value, which is also the threshold chosen in many studies, including Zhang et al. (2015), Nie et al. (2017), Wang et al. (2020) and Chen et al. (2021). As we and Wang et al. (2020) described, there are already more than thirty lists of glacial lakes within the Tibetan Plateau or High Mountain Asia, and we now publish the latest inventory of glacial lakes that includes the missing lakes from the previous inventories, and we believe that it is crucial to choose the same determination criteria as the mainstream lists.

Reviewer comment 3:
My suggestion for rejection is mainly because of the wrong selection of the topic. In this version it is hard to identify any novelty and originality, unfortunately. One solution for future will be to incorporate all glacial lakes into the inventory (as they promised in the title, by the way). The other possibility I see in comparison of different methods of RS inventory, that they can specify the accuracy on the example of the inventory. Other possibility will be wait for significant time difference, that the climate change could be identified.

Response 3:

We reiterate the editor's comments here: "As already indicated in your paper, the temporal evolution of glacial lakes across the Tibetan Plateau is a quite important research field and, hence, was already covered extensively by Wang et al. (2020) and Chen et al. (2021). Compared to those two studies, your data consists of temporal averages for three periods during 1990 to 2018 and therefore could be used for, e.g., trend analyses."

Apart from our response to the reviewer's first comment, novelty of our paper is also reflected in our use of a composite image extraction of glacial lake contours to fill the gap of glacial lakes in the Tibetan Plateau region since 1990. Although not the latest, this technique is indeed one of the first applications to extract glacial lakes on a large scale in the Tibetan Plateau. At the same time, with the development of satellite technology and the improvement of image quality, we are ready to update the inventory of glacial lakes with higher accuracy and newer in time next. Regarding the climate change aspect, we are carrying out some research and we hope to have a more in-depth discussion with you then for future publication.

We would appreciate if the reviewer can re-review our manuscript wholeheartedly as a dataset paper which (we believe) is of very much useful to many researchers working in this field.

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