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Reply on RC2

Muchu Lesi et al.

Author comment on "Landsat and Sentinel-derived glacial lake dataset in the China-Pakistan Economic Corridor from 1990 to 2020" by Muchu Lesi et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2021-468-AC2, 2022

Referee #2

The glacial lake dataset presented in 'Landsat and Sentinel-derived glacial lake dataset in the China-Pakistan Economic Corridor from 1990 to 2020' identifies and classifies lakes in the CPEC region of High-mountain Asia from three time steps - 1990, 2000 and 2020.

Lakes are identified from Landsat and Sentinel-2 optical satellite imagery using a semi-automated approach that utilises the well-established NDWI (Normalised Difference Water Index) method. Statistics and analysis of lake abundance and size distribution are presented, along with changes in lakes over the course of the time-series and inter-comparison of the Landsat- and Sentinel-derived lake outlines. The dataset is then compared to alike glacial lake datasets from the same region, in order to examine and evaluate discrepancies.

This is a valuable dataset that I foresee will be readily used by the cryosphere and hydrology research communities. In particular, the use of two highly-detailed lake classification systems (based on Gardelle et al., 2011, and a modified version of Yao, 2018) is a unique aspect of the dataset that is insightful alongside the general size and abundance information. This type of classification is seldom seen in glacial lake datasets, and reflects the thoroughness of the dataset.

The manuscript is structured in a clear and concise manner, guiding the reader through the dataset methods and description, results and statistics from the datastes, followed by an evaluation of the dataset scope and certainty.

Several key points need to be addressed, which are detailed below, largely regarding the dataset itself and the definition of a glacial lake. The comparison to alike datasets is flawed given that many of the discrepancies are due to the differing definitions of a glacial lake, rather than the classification method itself. Once these major revisions have been addressed, then the manuscript and associated dataset will be a great addition to ESSD.

[Response] We thank the reviewer for her/his positive assessment of the work and for her/his constructive comments, which have helped us to improve the quality of this article. We respond to the comments point by point as follows.

Major comments

1. Dataset transparency

A large part of the presented dataset is manually derived - metadata generation, georeferencing, and outline modifications. This can make reproducibility challenging. I would like to see a version of this dataset provided in the supplementary material that presents the dataset before manual intervention/inputs. Therefore, readers can see the dataset before and after manual modifications, and tangibly distinguish the automated and user-defined components of the methodology presented.

[Response] In this study, we used a human-interactive, semi-automated lake mapping method (Wang et al., 2014; Nie et al., 2017, 2020) to accurately extract glacial lake extents. The used method is flexible and of high reproducibility to map lake boundary by tuning NDWI threshold while screening the NDWI histogram, and automatically generating vector polygons. More detailed information can be seen in our previous publications, such as Wang et al., 2014. In the process of interactive lake mapping, manual inputs refer to the drawing of user-defined region of interest (ROI) and tuning the NDWI threshold in each ROI, whereas calculating the histogram of NDWI and converting raster lake extent to vector polygon were automated. Our lake dataset contains pixelated polygons, rather than manually digitized polygons. We do not provide the dataset before and after manual modifications because of the absence of manually-modified lake polygons. To avoid misunderstanding, we define the method as a human-interactive and semi-automated lake mapping method and made some revision. It now reads:

‘Specifically, the method calculated the NDWI histogram based on the pixels with each user-defined and manually-drawn region of interest. The NDWI threshold that separates lake surface from land was interactively determined by screening the NDWI histogram against the lake region in the imagery (Wang et al., 2014; Nie et al., 2020). This way, the determined NDWI threshold can be well-tuned to adapt various spectral conditions of the studied glacier lakes. The raster lake extents segmented by the thresholds were then automatically converted to vector polygons.’

2. Definition of a glacial lake

A large focus in the manuscript is glacier-related hazards, specifically GLOFs and draining lakes that are either on or share a boundary with a glacier. However, the dataset includes lakes that are not influenced or effect glacier dynamics, such as lakes that are hydrologically unconnected from a glacier. The abundance of glaciologically-unconnected lakes markedly influences the identified trends in the dataset, such as the visible influence on lake abundance in GLCS1. In addition, the dataset lacks a spatial filter relative to the ice margin. If indeed the aim of the dataset is to inform on glacier-related hazards, this dataset should focus exclusively on active glacial lakes, rather than active and ancient lakes.

[Response] The focus of this study is to provide a complete glacial lake dataset based on Landsat and Sentinel images, which has potential to be widely applied in studies on glacial lake-related hazards, glacier-lake interactions and cryospheric hydrology. We made some modifications to be more explicit about the goals of this study and the importance of our dataset. For example, we clarified that ‘This comprehensive glacial lake dataset has potential to be widely applied in studies on glacial lake-related hazards, glacier-lake interactions and cryospheric hydrology…’

We agree that most draining lakes that are either on or share a boundary with a glacier. If any studies want to conduct GLOFs risk assessment, one can select the candidate lakes by setting threshold in lake types and areas that are available in our dataset attributes. Lakes, including hydrologically-unconnected from a glacier, inactive and ancient lakes, formed as a result of glaciology and still impact land surface hydrology. Thus, all glacial lakes have to be mapped in lake inventories.

Both Randolph Glacier Inventory version 6.0 (Pfeffer et al., 2014; RGI Consortium, 2017) and the Glacier Area Mapping for Discharge from the Asian Mountains (GAMDAM) glacier inventory (Sakai, 2019) were used to affirm the ice margin during classifying lake type. It now reads:

‘These two glacier datasets were used to determine glacial lake types, such as ice-contact, ice-dammed and unconnected-glacier-fed lakes.’

Another aspect is the small threshold size used for the glacial lake dataset. Again, if the focus of this paper is glacier-related hazards then small lakes (<0.05 sq km; Shugar et al., 2021) are largely irrelevant to this study as they have limited GLOF impact. These small lakes make up over 80% of the dataset and heavily influence the identified temporal trends.

[Response] This comment was echoed by reviewer #1. We agree that small lakes have little or no hazardous impact due to their limited water release. The focus of this study is to generate a new glacial lake dataset for the CPEC, using 5 pixels as the mapping threshold for both Landsat and Sentinel images. We opted to map all glacial lakes, including small ones. If users want to conduct GLOFs hazard risk studies, they have the flexibility to set a threshold, such as greater than 0.05 km^2, to select lakes using our dataset to eliminate the impact of small lakes. Small lakes such as supraglacial lakes play an important role in understanding meltwater runoff and supraglacial drainage systems. Thus our dataset has potential to be widely applied in studies on glacial lake-related hazards, glacier-lake interactions and cryospheric hydrology. We have made some changes in the Abstract and main text, it now reads:

‘An up-to-date high-quality glacial lake dataset with parameters such as lake type, acquisition date and area, which is fundamental to flood risk assessments and predicting glacier-lake evolutions and cryosphere-hydrological changes…’

‘This comprehensive glacial lake dataset has potential to be widely applied in studies on glacial lake-related hazards, glacier-lake interactions and cryospheric hydrology…’

‘Small lakes such as supraglacial lakes play an important role in understanding meltwater runoff and supraglacial drainage systems (Liu and Mayer, 2015; Miles et al., 2018). Our dataset can be used not only for GLOFs evaluation, but also for glacial lake evolution simulation and glacio-hydrological prediction.’

In order to overcome this, I would suggest shifting the focus of the manuscript away from glacier-related hazards and framing the manuscript under the importance of freshwater transfer and storage in the region. Whilst Section 4.1 adequately outlines the definition of glacial lake, I think a brief definition should be defined early in the manuscript to assist framing the focus of the manuscript. Additionally, I would like to see a passage in the results/discussion that analyses active glacial lakes, under which their relation to glacier-hazards and GLOFs can be addressed. The comparison to other glacial lake datasets should be revisited to provide an adequate examination that focuses on discrepancies in the classification methodologies rather than the definition of a glacial lake.

[Response] Thanks for this suggestion. The focus of this study is to provide a complete glacial lake dataset based on Landsat and Sentinel images, which has potential to be widely applied in studies on glacial lake-related hazards, glacier-lake interactions and cryospheric hydrology. Considering freshwater transfer and storage in the region is part of the study of cryospheric hydrology.

We put the definition of glacial lake in the section 4 Glacial lake inventory methods. This section is composed of 4.1 Definition of glacial lakes, 4.2 Interactive lake mapping, 4.3 Classification of glacial lakes, 4.4 Attributes of glacial lake data and 4.5 Improved uncertainty estimating method.

As suggested, we add one paragraph in the discussion to analyze active glacial lakes related to GLOFs. It now reads:

‘The high consistency of Sentinel-2 and Landsat derived glacial lake products in 2020 assures the value of our lake dataset. Taking the usage in assessing GLOFs as an example, we set 0.05 km^2 as the area threshold to select object lakes, including ice-contact lakes and ice-dammed lakes that are the most active lakes and source lakes of GLOFs in the CPEC (Nie et al., 2021). A total of 24 and 29 ice-contact lakes were selected from Landsat and Sentinel-derived products, respectively. Among them, there were 4 ice-dammed lakes from the Landsat-derived product and 5 from the Sentinel-derived product. These selected lakes can be used for GLOFs hazard evaluation. Because of the high consistency between our Landsat and Sentinel-based mappings, users may have the flexibility to customize the lake size criteria to facilitate their specific purposes.

’

Regarding to the comparison to other glacial lake datasets, it is arduous to compare discrepancies between glacial lake datasets in the classification methodologies due to their low overlap. The highest overlapping rate is only 74% in count with Wang’s data (2020), followed by Chen’ highest overlapping rate of 45% in count. Zhang’s and Shugar’s dataset do not include lake type attribute. Hence, we can not make a comparison in the classification methodologies.

3. Broader overview of remote sensing classification methods

Optical classification methods are solely focused on in the introduction section of the manuscript (L86-103), which falsely represents them as the sole classification method readily used in remote sensing. I would like to see the overview include other remote sensing classification methods, namely SAR backscatter classification, but also other alternative approaches such as from hydrological sink analysis and from land surface temperature.

[Response] We added other classification methods besides optimal remote sensing. It new reads:

‘Backscatter images from Synthetic Aperture Radar (SAR) (Wangchuk and Bolch, 2020; How et al., 2021) were used to remove the impact of cloud cover for lake mapping. Besides, other approaches such as hydrological sink detection using DEM (How et al., 2021) and land surface temperature-based detection method (Zhao et al., 2020) were also used for lake inventories. Different classification methods impact the results of lake mapping and monitoring.’

I am not sure if there are any studies in this region where alternative classification methods are used to detect water bodies; but if there are any then I think they would be a great addition to the dataset comparison section to serve as an inter-comparison of methodologies beyond alike optical classification approaches.

[Response] To our best knowledge, glacial lake dataset produced based on SAR backscatter classification or hydrological sink analysis is not available in the study area. If available in the future, we are glad to make such a comparison.

Specific comments

L41-66: I think this a detailed and concise overview of the importance of glacial lakes and GLOFs in a regional context. However, I think a global perspective is needed to thoroughly illustrate the significance of this study - especially if you are referring to global studies of glacial lakes, such as Shugar et al. (2021). Please include a sentence or two near the beginning about glacial lakes and GLOFs globally (i.e. importance, general trends etc.)

[Response] As suggested, we have added a sentence herein 'Global glacial lake number and total area both increased between 1990 and 2018 in response to glacier retreat and climate change (Shugar et al., 2020), which inevitably affected the risk of GLOFs.'

L67-85: You largely focus on remote sensing efforts in HMA regional studies, but there are also references to papers from other regions such as Greenland and the Alps. Either open up this section as an overview of remote sensing studies from all regions, or keep it refined to the HMA region. There have been many regional studies that have been published recently (e.g. Alaska, Rick et al., 2022; Greenland, How et al., 2021), not just in HMA, so I would recommend widening this section to outline the methods in a general context, rather than focusing on HMA.

[Response] Thank you and we have cited the suggested recent publications for other regions. It now reads:

‘…the Alaska (Rick et al., 2022), the Greenland (How et al., 2021)…’

L92: What exactly do you mean by object-oriented classification here? This term is generally used in programming rather than in reference to a classification approach. Please change this, or clarify what is meant here; preferably with a more suitable term.

[Response] We deleted ‘object-oriented classification’.

L117-119: Are these sub-basins divided by catchments and/or watershed? What determines these sub-basins?

[Response] Yes, these sub-basins are divided by catchment based on major tributary rivers and DEM data.

L132-170: Great outline of data sources.

[Response] Thank you for your positive comment.

L178: Why are landslide-dammed lakes irrelevant to glaciation? Can some glacial lakes also be landslide-dammed lakes?

[Response] In this study, we accept the definition of a glacial lake as one that formed as a result of modern or ancient glaciation. Landslide-dammed lakes formed behind landslides, and have little connection with glaciation. Landslide-dammed lakes vary greatly with time and differ from glacial lakes, hence being exceeded in our dataset.

In a particular situation, glacial lakes are also dammed by landslides, someone may define those lakes as landslide-dammed lakes. Our study focuses on all glacial lakes formed as a result of glaciation.

L199: Change 'the method automatically generated the histogram...' to 'the method calculated the histogram...'

[Response] Revised as ‘Specifically, the method calculated the NDWI histogram based on the pixels with each user-defined and manually-drawn region of interest.’

L201: Change 'interactively' to 'manually'. In reference to this comment and the last, I think it needs to be clear in the methodology how this approach is 'semi-automated'.

[Response] We think 'interactively' is more suitable than 'manually' to depict the process of lake mapping. We needed to switch the screening NDWI and original image to determine an optimal threshold, and this is an interactive process. In the process of interactive lake mapping, manual inputs refer to drawing user-defined region of interest (ROI) and tuning the NDWI threshold in each ROI, whereas calculating the histogram of NDWI and converting raster lake extent to vector polygon are automated. To avoid the misunderstanding, we define the method as a human-interactive and automated lake mapping method and made some revision. It now reads:

‘Specifically, the method calculated the NDWI histogram based on the pixels with each user-defined and manually-drawn region of interest. The NDWI threshold that separates lake surface from land was interactively determined by screening the NDWI histogram against the lake region in the imagery (Wang et al., 2014; Nie et al., 2020). This way, the determined NDWI threshold can be well-tuned to adapt various spectral conditions of the studied glacier lakes. The raster lake extents segmented by the thresholds were then automatically converted to vector polygons.’

L224-228: False classifications from cloud and topographic shadows can be eliminated with cloud and terrain masking, which are well-established remote sensing methods in land classification. Why did you choose not to include this in the automated component of your workflow?

[Response] We selected high-quality images to map glacial lakes for each time period. However, false lake extents resulting from cloud or snow cover, lake ice, and topographic shadows are unavoidable but limited. Then, we removed those false lakes and again mapped the lakes using our lake mapping method according to alternative images acquired in adjacent years. This method meets the needs of lake mapping. Incorporating cloud and terrain masking in the automated process is an excellent suggestion, and we will consider this in the future research.

Table 1: The characteristics of a proglacial lake should specify that these lakes share a boundary with the ice margin, according to your definition - 'shared boundary' is a better description than 'connected with glaciers' as this could be interpreted as hydrologically connected instead of physically adjacent.

[Response] Replaced 'connected with glaciers' with 'shared boundary with glaciers '.

Table 2: There must be occurrences where a lake's formation and/or dam material properties are ambiguous (especially in relation to GLCS2), even from Google Earth imagery. I see in the dataset that there are no instances where a lake's classification is determined as uncertain; even though you state later on that occassional misclassifications are inevitable (L561). In such instances of ambiguous lake types, how do you decide the classification?

[Response] Yes, some dam material properties are ambiguous from satellite observations.

This is a challenge for GLCS2. Differentiating moraine-dammed and glacial-erosion lakes is challenging due to unclear moraine dam or bedrock superimposed by top moraine. To differentiate those dam types, we considered auxiliary factors that help classify lake dam types, such as location, surface slope, roughness and shape of the glacial lakes. We established the classification system of lake types and collected typical samples for each lake type to train our operators at the beginning of the classification. We then used our expert knowledge to classify all lakes with a combination of glacier data, DEM, geomorphological features. When indeterminate lake types emerged, we used group discussions to attribute the type. All these steps help us improve the quality of lake datasets that are more useful to users.

We proposed the limitation and updating plan in the main text:

‘Although very high-resolution Google Earth images were utilized to assist in lake type interpretation, occasional misclassification was inevitable. We implemented two types of classification systems based on a careful utilization of glacier data, DEM, geomorphological features and expert knowledge. However, the lack of in situ survey prohibited a thorough validation of the glacial lake types.’

‘The glacial lake dataset will be updated using newly collected Landsat and Sentinel images at a five-year interval or modified according to user feedbacks.’

L272-273: Please provide references to studies that use lake perimeter and displacement error to estimate uncertainty.

[Response] We added the citations, and it now reads:

‘Lake perimeter and displacement error are widely used to estimate the uncertainty of glacier and lake mapping from satellite observation (Carrivick and Quincey, 2014; Hanshaw and Bookhagen, 2014; Wang et al., 2020).’

L270-295: Repetition with the corresponding uncertainty estimation section in the supplementary materials. I would suggest refining this section in the main manuscript, and keeping the full description for the supplementary materials.

[Response] We removed the duplicate section on uncertainty estimation in the supplementary material, and moved Tutorial for Improved Uncertainty Estimating Method at the end of the main text as an appendix. We want editors to approve these changes.

L294 and L305: Change figure names from Figure S3a/S3b to Figure 3a/3b, unless you would rather move them to the supplementary materials.

[Response] Revised as “Figure 3a” and “Figure 3b”.

Figure 4: This is a great figure. Please add labelling to the figure to indicate that one set of graphs is from Landsat and the other from Sentinel - you only understand this once you have read to the end of the caption, and it needs to be signposted earlier.

[Response] We have added Landsat and Sentinel at the upper left corner of the figure 4 to differentiate.

L339: 'proglacier' >> 'proglacial'

[Response] According to suggestions from Reviewer #1, we replaced 'proglacial' with ‘ice-contact’ and corrected the typo.

Figure 5: The four maps are somewhat repetitive and it is difficult to see differences between the Sentinel and Landsat lake sizes/abundance from this. I would suggest changing this figure to have an overview map on the left showing all detected lakes from both methods, and a series of inset maps to the right displaying a closer look at certain regions of interest; divided into Sentinel and Landsat lakes. Also, maybe change the outline colour of the lake points to a darker shade, as it is hard to identify the lake points in the current figure.

[Response] The figure 5 aims to describe the distribution of glacial lakes in 2020 extracted from Landsat and Sentinel, and all lakes are classified by GLCS1 and GLCS2. From this point of view, it is not repetitive. For clarity, we added ‘Landsat’ for ‘panels a and b’, and ‘Sentinel’ for ‘panels c and d’. Meanwhile, differences in glacial lakes from Landsat and Sentinel can be clearly seen compared to "Panels a and c" using GLCS1 and "Panels b and d" using GLCS2. A closer look at certain regions of interest is showed in figure 11 and 12. That is why we designed this Figure.

As suggested, we set the outline of lake points to black with a thicker size in order to better differentiate the lake points.

L352: This is a hanging line, and I am not sure which panels and sub-graphs are being referred to here. Does this belong somewhere else or is this a fault with the journal formatting?

[Response] We corrected this typo and ensure all captions are complete in the main text.

Figure 7 and 8: These graphs are very effective at showing changes in lakes - a refreshing take on presenting this type of dataset.

[Response] Thank you very much.

L382: '...while the area grew by a less extent (1.21 km^2 or 1.42%).' >> '...while the area grew by 1.21 km^2 (or 1.42%).'

[Response] Revised as ‘while the area grew by 1.21 km^2 (or 1.42%).’

L408: '...including being stable for Shingo...' >> '...including a stable trend for Shingo...'

[Response] Revised as ‘...including a stable trend for Shingo...’

L411-412: 'The total numbers of Kashgar and Hunza basins decreased...' >> 'The total number of lakes in Kashgar and Hunza basins decreased...'

[Response] Revised as ‘The total number of lakes in Kashgar and Hunza basins decreased...’

L426-27 and Table 5: Can you include some statistics on the link between lake size and % overlap between the Sentinel-2 and Landsat counts? - this would help gauge how much spatial resolution (differentiated from image acquisition) affects lake classification in this study.

[Response] Thanks for this suggestion. We tried but did not find any significant statistics between lake sizes and overlapping rates. Impact of spatial resolutions on classification accuracy of lake types is very interesting. We hope to conduct such studies in the future, however this is beyond the goal of this study.

L441-443: Are these lakes persistently large or just at a particular time step? Do you have evidence as to why they are disproportionally large?

[Response] These lakes are persistently large, and we deleted 'disproportionally' to avoid any misunderstandings.

L481-485: Can you state here the number of instances where overlapping acquisitions were acquired?

[Response] Revised as '…is relatively low (only 7 scenes of Sentinel images or 112 glacial lakes in 2020)…'

L492: 'approximate' >> 'approximately'

[Response] Changed to 'approximately'.

L503-504: Are there any studies that present glacial lake datasets derived from

Sentinel-2? If so, please reference them here. If not, then change this to state that there are no comparable datasets, rather than a scarce number of datasets.

[Response] Agreed, it new reads:

'Regional glacial lake datasets using Sentinel images are scarce. Lack of Sentinel-derived glacial lake datasets in the study area makes it impossible to compare.'

L515-521: I think, similar to your suggestion regarding landslide-dammed lakes, a likely answer is that Wang et al. focus more on glacier-connected lakes, given that they adopt a 10 km buffer to filter out unconnected lakes. And therefore they identify an increasing trend, possibly reflective of a subset of your lake types. Could you subset your lake dataset to match the lakes identified by Wang et al., and examine whether you also see this increasing trend evident in your subsetted dataset? (And perhaps also include landslide-dammed lake for the purpose of this comparison?)

[Response] Both Wang' study and ours are regional-scale glacial lake inventories and do not only focus on active lakes. Regarding discrepancy, all glacial lakes in the study area were mapped according to our definition regardless of the proximity to glaciers whilst Wang's data was filtered by a 10-km buffer zone from glaciers. That is the reason that we mapped more lakes than Wang's for each time period. Our lakes dataset maps all glacial lakes in the study area for the first time, making up for missing lakes in other datasets. The missing lakes are mostly non-glacier-fed lakes that remain relatively stable in the past decades (Figure 7), having little impact on changing trend in glacial lakes.

Our study demonstrates that end-moraine-dammed lakes increased by 2.48 km^2 and contributed most of the glacier lake area expansion, whereas supraglacial, ice-dammed and lateral-moraine-dammed lakes decreased slightly in both number and area. This trend is consistent with the slightly negative mass balance of glaciers in the study area (covering Pamir, Karakoram etc.). Based on the analysis of Wang's data, we find that newly-emerged and expanded landslide-dammed lakes contributed most to the increase in lake area, and manually delineating glacial lakes twice by different operators exacerbated the errors of mapping. These reasons result in an increasing trend in their study. We have proposed the reason in the main text.

Landslide-dammed lakes fluctuate greatly with time and expanded recently in the study area, differing from typical glacial lakes. According to our definition on glacial lakes, Landslide-dammed lakes are excluded. Our dataset shows a long-term regional changing trend of all glacial lakes. A comparison in the condition of including landslide-dammed lakes is beyond the goal of our present study and seems unnecessary. Thanks for your support and understanding.

L530: "Zhang's dataset..." >> "The dataset from Zhang et al. (2015) ..."

[Response] Revised as 'The dataset from Zhang et al. (2015)...'

L531-536: I am unsure how this study and Zhang et al. could have discrepancies in image availability when both studies are classifying lakes from the same satellite image collection (Landsat). Some clarification is needed here to demonstrate how your dataset could classify these lakes when Zhang et al. could not.

[Response] We revised this sentence. It now reads:

'…we attributed this anomalous discrepancy to a range of glacial lakes that were missing due to lack of thorough cross-check quality assurance and the limit of a 10-km buffer zone from glaciers during their manual delineation.'

L538-544: Discrepancies in glacial lake datasets can be because of minimum lake size, classification method (i.e. not just optical), image acquisition and post-filtering. However, if the purpose of this dataset is to 'further promote the capacity of GLOF risk assessment and predicting glacier evolutions' then I am unsure why there is no spatial filter (relative to ice margin position) adopted to remove lakes that are unconnected to the glacial system. I think the focus of this study needs to be shifted (as stated earlier in major comments), and further analysis needs to be presented that demonstrates changes in GLOF and glacier-fed lakes specifically (i.e. filtered by lake type and size) - see major comments for full details.

[Response] The focus of this study is to provide a complete glacial lake dataset based on Landsat and Sentinel images, which has potential to be widely applied in studies on glacial lake-related hazards, glacier-lake interactions and cryospheric hydrology. We made some modifications to be more explicit about the goals of this study and the importance of our dataset. The sentence was changed to:

'…we provide an up-to-date glacial lake dataset derived from both Landsat and Sentinel observations, which further increased the availability of glacial lake datasets for GLOFs risk assessment, predicting glacier evolutions (Carrivick et al., 2020) cryosphere-hydrological changes…'

L550: 'Even though an capacity of repetitive observations...' >> 'Even though the capacity of repeat observations...'

[Response] Revised as 'Even though the capacity of repeat observations...'

L557: '...inter- and intra-annual changes (Liu et al., 2020) in glacial lake dataset of each time period...' >> '...inter- and intra-annual changes (Lie et al., 2020) for each time period...'

[Response] Revised as '...inter- and intra-annual changes (Liu et al., 2020) for each time period...'

L545-564: This is a valuable section to include in the study. The temporal range of these datasets and limited image availability (especially in formative years) will not adequately capture the dynamic nature of draining glacial lakes; and therefore such datasets serve as a gauge of long-term, regional trends rather than individual lake change.

[Response] We are thankful for your support and understanding.

L565-575: It is great to hear that this work will be continued, and new time steps will be included in the dataset in the future.

[Response] Thanks for your encouragement.

L584: '...spatial-temporal changes at longer time scale...' >> '...spatial-temporal changes at a longer time scale...'

[Response] Revised as ' ...spatial-temporal changes at a longer time scale... '.

L584: 'observation' >> 'observations'

[Response] Revised as ' observations '.

L585: 'started' >> 'starting'

[Response] Revised as ' starting '.

L595-596: See previous comment from L538-544 regarding this statement.

[Response] As responded to earlier questions. This sentence was changed to:

'…maximize their potential utility for GLOFs risk evaluation, cryosphere-hydrological and glacier-lake evolution projection.'

L602: 'values for cryospheric-hydrology research, assessment of...' >> 'value to cryospheric-hydrology research, the assessment of...'

[Response] Revised as 'value to cryospheric-hydrology research, the assessment of... '

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