Dear Reviewers,

Thank you for your comments. We revised the manuscript considering all the reviewers' feedback. We improved the abstract by highlighting the main findings of the study. As suggested, we clarified in the introduction the main hypotheses that guided the work. We have also substantially expanded the discussion section, including a discussion on the feasibility of generating similar datasets, a comparison with previous studies, as well as addressing all the points raised in the introduction such as sediment connectivity and 'peak water'. We also improved the figures based on reviewer feedback and updated the reference list.
Below are all the point-by-point responses to the reviewer's comments.

Response to the reviewer's comments

RC1: 'Comment on esurf-2022-63, Anonymous Referee #1
The presented work provides a significant contribution to quantitative research on fluvial sediment changes by estimating the sediment balance of a main Alpine river (Fagge River, European Alps) in a glaciated catchment system (Kaunertal in Austria), using multiple sources of historical and digital images and LiDAR data. Nineteen survey periods from 1953 to 2019 spanning inter-survey periods between one month and 16 years are analysed by using high-resolution DEMs. The analyses allow for identifying periods of different sediment budgets and for relating detected changes to glacier front variation, lateral hillslope activity and runoff events as well as to the location and activation of possible sediment sources.
This work can certainly contribute to solving one of the key problem of existing current studies, which is the lack of information over a longer time period. Process monitoring efforts are usually restricted to a few decades (at best). The material is very well presented and the manuscript is in all parts very well written. The manuscript is in my eyes excellent and has no significant flaws.

--- *We thank you for your positive feedback and for the comments!*

However, I have one issue the authors might consider: The authors highlight that their detailed analyses are built on a unique dataset. Referring to this point, I would like to ask if some more critical discussion on the potential of using the selected approach also in other study areas could be added. How likely is it to carry out this type of in-depth study in a successful way also in other glaciated catchment in the European Alps and in other high-mountain areas worldwide?

--- *Thank you for the suggestion and we added in the discussion section a paragraph on the feasibility of generating similar datasets.*
"It is feasible to generate high spatial and temporal resolution DEMs in other glaciated catchments in the European Alps or in other high-mountain areas worldwide, but the lack of available data is a significant challenge. Concerning historical aerial images, there is a lack of overview of aerial image archives with regard to their spatial and temporal coverage. In addition, many archives of historical aerial images are not freely accessible and images collected for military purposes have yet to be declassified or have restricted access. One additional problem is the image quality, which is often compromised by photo processing, physical storage conditions, and the digitisation process, i.e., the distortion introduced during the scanning and the resolution of the scan (Stark et al., 2022). Furthermore, external information such as camera calibration certificates required for accurate photogrammetric processing, is often missing. Nevertheless, automated methods using SfM are currently being developed to process historical aerial images and generate time series DEMs and high-resolution orthoimages (Knuth et al., 2023). Images from the declassified stereo spy satellites from the Corona (Dehecq et al., 2020; Ghuffar et al., 2023) and Hexagon KH-9 missions can be easily accessed via the USGS Earth Explorer portal (free of charge for images that have already been scanned) and offer great potential for DEM reconstruction for geomorphic change detection (Maurer et al., 2015). However, despite their global coverage, their period of acquisition ranges between the 1960s and 1980s and their ground resolution from approximately 2 m to 8 m. From the year 2000, private companies often conduct airborne digital photogrammetric and Lidar surveys, but rarely make the data available. Modern high-resolution stereo satellite images with metric to sub-metric resolution (e.g. Worldview and

Pléiades) are commercially available after 2005 and can be used for large-scale DEM reconstruction, but they are not freely available and have limited temporal resolution. Consequently, studies in Alpine catchments with high spatial and temporal resolution datasets dating back to the last century are still very limited, preventing the comparison of spatio-temporal variation in sediment dynamics and the assessment of the response of catchment-scale sediment yield to climate change."

Stark, M., Rom J., Haas F., Piermattei L., Fleischer F., Altmann M., Becht M: Long-term assessment of terrain changes and calculation of erosion rates in an alpine catchment based on SfM-MVS processing of historical aerial images. How camera information and processing strategy affect quantitative analysis. Journal of Geomorphology: 43-77, 2022.
Maurer, J. and Rupper, S.: Tapping into the Hexagon spy imagery database: A new automated pipeline for geomorphic change detection. ISPRS Journal of Photogrammetry and Remote Sensing, 108, pp.113-127, 2015.
Ghuffar, S., Bolch, T., Rupnik, E. and Bhattacharya, A.: A Pipeline for Automated Processing of Declassified Corona KH-4 (1962–1972) Stereo Imagery. IEEE Transactions on Geoscience and Remote Sensing, 60, pp.1-14, 2022
Dehecq, A., Gardner, A.S., Alexandrov, O., McMichael, S., Hugonnet, R., Shean, D. and Marty, M.: Automated processing of declassified KH-9 Hexagon satellite images for global elevation change analysis since the 1970s. Frontiers in Earth Science, 8, p.566802, 2020.

How likely is it to create directly comparable results for different selected study sites within the European Alps and worldwide? Please judge also the possible restrictions.
--- Thank you for this question. We clarified the possibility of comparing results for different catchments in the discussion.
Comparing sediment balances between different study sites is very challenging due to the complexity of the mountain environment and the high dynamics of the river system in proglacial areas, which are subject to different forcing and with varying lengths of deglaciation periods. In addition, differences in the dataset and survey period may introduce another source of «lacking comparability» between the study areas. However, if data of comparable quality and spatial/temporal resolution are available, it is possible to identify site-specific developments and/or common trends, as well as general processes affecting the proglacial area and Alpine catchments.
"The emergence of new glacial forefields previously ice-covered is the first evidence of unprecedented rapid glacier melt caused by rising temperatures and longer heat waves that are affecting all Alpine glaciated catchments worldwide. Carrivick et al. (2013) and Baewert and Morche (2014) in their study show that erosion is the dominating process that takes place in the proximal area of the glacier and accumulation generally occurs in the distal area. Similarly, Anderson and Shean (2021) in their study of proglacial erosion rate found that exported materials tended to accumulate in large deposits below the proglacial limits, to then be distributed over subsequent decades or centuries. However, we show that fluvial sediment storage varies considerably depending on factors such as the local topography of the newly exposed active floodplain (bedrock versus sediment glacier bed, confinement versus presence of "accommodation space"), increasing floodplain area with the formation of new channel, sediment connectivity, and the subsequent sediment source from the lateral moraine. Thereby, retreating glaciers may uncover clean bedrock or may reveal large sediment sources stored in their former lateral and ground moraines. The amount of these glacigenic sediments depends on the sediment balance of the retreating glacier, which is a function of the sediment production of the rock wall erosion and the erosional potential of the glacier runoff, i.e. slope, balance, and precipitation (Zemp et al. 2005).
In addition, a single localized event such as an extreme precipitation event or the outburst of a subglacial water pocket can cause massive changes in the channel system, as also concluded by Anderson and Shean (2021), and numerous studies on the European Alps (e.g. Baewert and Morche, 2014, Lane et al. 2016, and Carrivick et al. 2013; 2018) and Himalaya (Cook et al., 2018). Furthermore, Buter et al. (2022) and Savi et al. (2023) note that intense rainfall events play a critical role in promoting and enhancing functional sediment connectivity (Wainwright et al., 2011) among landforms that are already structurally connected. In addition, extreme events can modify the structural connectivity by removing barriers to sediment fluxes (Turley et al. (2021)."