26 Jan 2024
Dear Topic Editor,

Response to Reviewer Comments for ESSD-2023-422
The authors would like to thank two anonymous reviewers for reviewing this manuscript. The authors sincerely thank the reviewers' comments and suggestions. In the following sections, we provide a point-to-point response to the comments. The original comments are provided in black, followed by our responses in blue. We believe that the concerns of one of the reviewers have been addressed. Please let us know if there are any questions or queries. Thanks again to the editor and the reviewers for their valuable time, suggestions, and comments.

Yours sincerely,

Dr Yuhan Guo (on behalf of all co-authors)
State Key Laboratory of Hydroscience and Engineering,
Department of Hydraulic Engineering, Tsinghua University, Beijing, 100101, China
Email: guoyuhan@tsinghua.edu.cn;

Reviewer 1：

Review of the manuscript 'A hydrogeomorphic dataset for characterizing catchment hydrological behavior across the Tibetan Plateau' submitted to ESSD.

Recommendation: ACCEPT

The Focus of the paper is on hydrologic and geomorphic processes which are intricately linked within the Earth system. Such systems are jointly characterizing terrestrial hydrological behaviors and biogeochemical cycles across diverse temporal and spatial scales.

Relevance: The presented study is the original primary research within scope of the journal which gets insights into the Tibetan Plateau. The Tibetan Plateau provides an ideal setting for investigating the interactions between hydrological and geomorphic processes in a largely pristine natural environment.

Title: the title and abstract of this paper clearly reflect its content.

Abstract is well written and clearly describes the undertaken study.

Structure: The article is well organized with structured sections. The structure of the manuscript conforms to the journal standards and discipline norm. The numeration of the sections is correct and consecutive.

Logic: Overall, the presentation of the work clear, with regards to language and grammar. The clarity

of the text logic and organization of the paper is sufficient. It demonstrates the consistent interpretation of the results with detailed explanations and comments. A comparison of the results with those in previous studies is presented.

Introduction presents a background, defines research goals and provides a clear statement of research problem. The introduction presents the purpose of the research investigation and the purpose is supported by the pertinent literature. The Introduction well describes the research. Introduction and background show context of the article. Literature is well referenced and relevant. Study area: is described with sufficient details.

Research questions and goal are identified. Objectives are relevant to the study aim.
Literature regarding the relevant topics is reviewed, formatted according to the journal rules and appropriately referenced. Major sources include published papers on basin hydrology, geomorphology and Earth science data.
Research gaps and weakness in former works are described; the existing gaps are identified. The contribution of this work filling this gap is explained.
Motivation is explained: The interactions between hydrologic and geomorphic processes remain largely unknown due to challenging physical conditions and data limitations.

English language: acceptable. Clear, unambiguous, professional English language used throughout. Data used in this study are described: The authors presented a dataset which comprises 18 hydrogeomorphic metrics, particularly along with the width function and width function-based instantaneous unit hydrograph (WFIUH) of each catchment.

Methods: Methods described with sufficient detail and information to replicate. The methods are described sufficiently to allow the research study to be repeated by other parties in similar research. Modifications of the existing methods are mentioned briefly. The workflow is well structured and clearly described with sufficient information to reproduce the approach.

Results are reported: The authors assessed the data and found that the relationships of time-to-peak against the hydro-geomorphic metrics are similar to those of peak flow but in an opposite direction. Moreover, they revealed that catchment concentration time shows a positive relationship with catchment size but a strong negative correlation with catchment slope. The results are relevant to the initial research goals and objectives and report major achievements of this study.

Discussion interpreted the major outcomes of this study. Among others, the authors found and reported that the peak flow of WFIUH is positively related to slope and curvature but negatively related to catchment area, perimeter, length, and circularity. The advantages of the obtained results are described and compared for diverse hydrological and geomorphic setting of the region. The Discussion described the issues of methodology and results.
Conclusion Conclusions are well stated, linked to original research question, limited to supporting results and summarized the study with interpretation of facts. The methods presented by the authors can be employed for calculating flow velocity and are useful for similar studies. Moreover, the authors provided a link to the datasetvia the Zenodo portal. The conclusions are appropriately stated

and connected to the original questions.

Validation and accuracy: The validity of the derived WFIUH has been confirmed by its successful integration into an hourly hydrological model for simulating flash flood events.

Actuality, novelty and importance of the research is clear: This study presents the first version of a novel hydro-geomorphic dataset encompassing diverse catchments across the region of Tibet. Moreover, the presented study can contribute to advancing our understanding of catchment hydrological behaviour in the Tibetan Plateau and hence improving water resources management and disaster mitigation in the region and its downstream.

Academic contribution: Rigorous investigation performed to a high technical and professional standard. The paper increases the knowledge in hydrology and Earth sciences. The paper combines technical, modelling, cartographic and hydrological approaches to data analysis which presents a multi-disciplinary study well deserved to be published in ESSD.

Figures The authors presented 9 figures and 2 tables. The output illustrations are of acceptable quality, easy to read, relevant and suitable. Figures are labelled and appropriately described. They illustrate the results of the undertaken study.

Recommendation: This manuscript can be accepted based on the detailed report above.

With kind regards,
- Anonymous Reviewer.
07.12.2023.

Response: The authors wanted to express their sincere appreciation for the time and effort the reviewer dedicated to reviewing our manuscript thoroughly. We really appreciate the acknowledgment from the reviewer and your positive feedback is truly encouraging.

Reviewer 2：

Thank you very much for your time in reviewing our manuscript. We have read your comments and suggestions carefully and would like to clarify some issues you mentioned.

-This paper constructs a hydrological behavior dataset at catchment scale across the Tibetan Plateau. Different geomorphic derivatives and WFIUH are calculated to characterize this catchment hydrological behavior in the Tibetan Plateau. However, I personally believe the current manuscript ignores the major hydrological characteristics of the Tibetan Plateau. Actually, what we should mentioned about the hydrological characteristics in the Tibetan Plateau should be the exorheic and endorheic basins, the lake -catchment relationship, and the lake-stream relationship. However, from the entire manuscript, it is hard to find relate contents, which means the current hydrological behavior defined by the paper is misleading for the Tibetan Plateau. Still, what is the hydrological behavior in this paper for the Tibetan Plateau. I did not see the definition. And what's wrong with

existing contribution? Thus, I personally believe the scientific problem has been poorly defined. Without a clear scientific problem to guide the study, the following constructed dataset may be meaningless.

Response: We would like to clarify that we are not constructing a "hydrological behavior dataset". Instead, we are providing a "hydrogeomorphic dataset for characterizing hydrological behavior at a catchment scale". In such a case, we do not expect our dataset to characterize all hydrological behaviors at a catchment scale but are interested in the linkages between geomorphic metrics and catchment hydrological behavior characterized by flow concentration time, time to peak, and relative magnitude of peak flow, etc. These hydrological characteristics are critical for flash flood prediction for ungauged catchments, as we mentioned in the Introduction and emphasized in the abstract: "*It can contribute to advancing our understanding of catchment hydrological behaviors and providing simple and fast routing unit hydrograph calculation for ungauged catchments in the Tibetan Plateau, and hence improve water resources management and disaster mitigation in the region and its downstream.*" We agree that catchment hydrological behaviors in the Tibetan Plateau are highly complicated and cover many hydrological characteristics such as lake-catchment relation, exorheic and endorheic basins, glacier/permafrost-related hydrological processes and climate-induced hydrological change. These topics are all of great importance for understanding further the hydrological behavior of the region but are out of the scope of our dataset.

Other detailed comments can be found as follows.

-Actually, the Tibetan Plateau has numerous endorheic basins (mainly in the inland region in Figure 1), and their hydrological processes differ significantly from exorheic basins. Endorheic basins require specialized algorithms for determining flow directions. Based on the figures and words in the current paper, I think the authors only consider the characteristics of traditional exorheic basins (such as the catchment on the right side in Figure. 2). This issue can lead to the misunderstanding of hydrological behavior in the Tibetan Plateau.

Response: We acknowledge that the algorithms applied to determine flow directions of endorheic and exorheic basins can be slightly different (e.g., Prusevich et al., 2022). We however do not focus on producing specialized algorithms for determining flow directions, but on providing geomorphicly based unit hydrograph based on well-known flow direction products from Hydrosheds. The subplot in Figure 2 is for demonstration only. We added some context to clarify this: " *The Tibetan Plateau has numerous endorheic basins (mainly in the inland region in Figure 1), and the algorithms applied to determine flow directions of endorheic and exorheic basins can be slightly different (e.g., Prusevich et al. (2022). As this study does not focus on the algorithms determining flow direction but mainly on generating the WFIUH for flash flood modeling, we use the flow direction raster map from HydroSHEDS (https://www.hydrosheds.org/hydrosheds-core-downloads), which bases on DEM from NASA's Shuttle Radar Topography Mission (SRTM) with spatial resolution around 90m (Lehner et al., 2008).*" In the "Study area and data" part.

Prusevich, A., Lammers, R., & Glidden, S. (2022). MERIT-Plus Dataset: Delineation of endorheic basins in 5 and 15 min upscaled river networks (Version v1) [Data set]. MSD-LIVE Data Repository. https://doi.org/10.57931/1904379

-Additionally, the authors emphasized interaction but did not present enough analysis indicating the

interaction between the hydrological and the geomorphological characteristics. The authors computed hydrological indicators based on geomorphological derivatives and conducted a correlation analysis between WFIUH and geomorphological derivatives. However, these do not represent interactive processes. The authors should present more interaction considerations and explain how these factors influence each other. Actually, there are some papers related lake - catchment relationship and lake-stream relationship for the Tibetan Plateau. But it looks like the authors have not make a comprehensive review in relating research.

-The authors employed 'the interactions between hydrological and geomorphic processes' (Line 344). I suggest the authors refrain from using 'geomorphic processes'. This term typically refers to changes or evolution in landforms, but this paper does not have related content.

Response: Thank you for the advice. We have rephrased this sentence to "*The Tibetan Plateau provides an ideal setting for investigating the hydrological and geomorphic interactions between hydrological and geomorphic processes in a largely pristine natural environment, minimally impacted by human activities.*" Additionally, we'd like to clarify that this manuscript essentially is a data description submission rather than research on exploring the interactions between hydrologic and geomorphic processes. Nevertheless, based on our dataset, we found that the peak flow of a catchment is positively related to its slope and curvature but negatively related to its area, perimeter, length, and circularity. The relationships of time-to-peak against the hydrogeomorphic metrics are similar to those of peak flow but in an oppositive direction. Catchment concentration time shows a positive relationship with catchment size but a strong negative correlation with catchment slope as a steeper land surface can result in faster flow hence shortening the travelling time of water flow. We believe that these findings are important to understand the connections between geomorphic characteristics and catchment hydrological behaviors. Moreover, the dataset can be used to explore further the interactions between hydrological and geomorphic processes such as erosion and landslide assessment.

-The authors need to consider the timing of the acquisition of the used data. The SRTM was acquired in about 2002, and whether the FROM-GLC is produced at a time similar to the acquisition of the SRTM as well as the HydroSHEDs data? This could affect the accuracy of the results.

-There are many open-source DEMs with 1 arc-second (~30m) resolution, so why do you use the 90m resolution SRTM? Meanwhile, the authors used a resample to unify the pixel size of the land cover and the DEM. 90m-resolution data contains clear difference from 10m-resolution data. The resampling operation from 10m to 90m can introduce a large uncertainty.

Response: Thank you for the comments. Our dataset is developed based on the widely accepted HydroSHEDs dataset, which is derived from SRTM. For data consistency, we use SRTM as well to derive other hydrogeomorphic metrics and WFIUH.

-The authors chose four stations as the validation reference. However, as can be seen from Figure 1, these four stations are all concentrated in the northeastern part of the Tibetan Plateau, which only represents a very small area. There are no validation references for most of the other regions of the Tibetan Plateau. It is difficult to demonstrate the high confidence of the results with such a design.

Response: As mentioned in our manuscript, the Tibetan Plateau is a region with limited ground observations, providing limited opportunities for comprehensive validation. We have been searching for more observed hydrological data for validation but with little success, particularly for the

western part of the Tibetan Plateau.

-Some of the parameters selected by the authors are not reasonable. First, some of these factors are strongly correlated, and repeated use does not strengthen the credibility of the conclusions. It is need to perform a correlation analysis on the selected factors and eliminate the duplicates before the results are analyzed. Secondly, I do not think that mean elevation and mean slope can be used as representative parameters. The hydrological processes analyzed by the authors, although oriented towards the watershed scale, are still in fact analyzed at the pixel scale (especially the part that involves curve plotting). Mean elevation and mean slope are not conducive to exploring the relationship between hydrologic and geomorphic characteristics in this perspective. Perhaps an attempt could be made to calculate the variability (e.g., standard deviation, etc.) of slope or elevation within a watershed, and they might be more clearly related to watershed-scale surface hydrologic processes.

-I think the conclusions in this paper could be more in-depth. The authors get some results that are "obviously correct" even I do not employ all experiments. For example, Lines 358-359, "These results suggest that a catchment with a larger size and with a more circular shape may exhibit a more gradual rising limb in its hydrograph". We can obtain this information (when the circularity is larger, the surface runoff process will definitely proceed more evenly) before completing this experiment.

Response: Thank you for the comments. For clarification, in this research, we aim to provide a comprehensive dataset that includes the most commonly used hydrogeomorphic metrics. We believe the relationships among the metrics for catchments in the Tibetan Plateau were largely unknown before our research, particularly for the relationships among geomorphic metrics and the WFIUH.