**Responses to Reviewer 1**
Vamshi et al. “Global river flow data for aquatic exposure models developed from surface runoff based on the Curve Number method”
essd-2023-161

*“Thank you very much for inviting me to review this manuscript. In this paper, the authors produce a dataset on global annual mean surface runoff and another dataset on global annual mean river flow rate. The topic is interesting and important, and the method used in this study have been explained detailedly. Nonetheless, in my opinion, the manuscript should be further improved before it can be finally accepted, and I am a bit worry about the novelty of this study.”*

**Response:** We would like to thank the reviewer for the very helpful input provided that helped to improve the manuscript and clarify some key points in the previous manuscript version. Additionally, we have revised the introduction to elaborate on the focus of the key application and novelty of this dataset, and is discussed further below.

## Comment (1)

(a) “*As resolutions of all input data (land cover, soil group & precipitation) for driving the CN approach is larger than 250 m, why the runoff is produced at 50 m? Why not produce runoff data at 250m, 100 m, or 10 m? In addition, for many large rivers, the width of the river channel can be hundreds or thousands of meters. A high resolution, like 50 m, is necessary only when you are going to calculate the water flow in small rivers. However, in your approach, the small rivers in each of the small level-12 catchment have been aggregated. For a global river flow database, is it necessary to produce river discharge data at a resolution of 50 m?”*

(b) *“To my understanding, the only outstanding point of the runoff and river flow datasets produced in this study, compared with previous datasets, is the high spatial resolution (50 m). However, as I have expressed above, a spatial resolution of 50 m is not necessary for larger rivers. It can be very useful to calculate the river flows in small rivers. However, the authors have aggregated all small rivers in each small catchment.”*

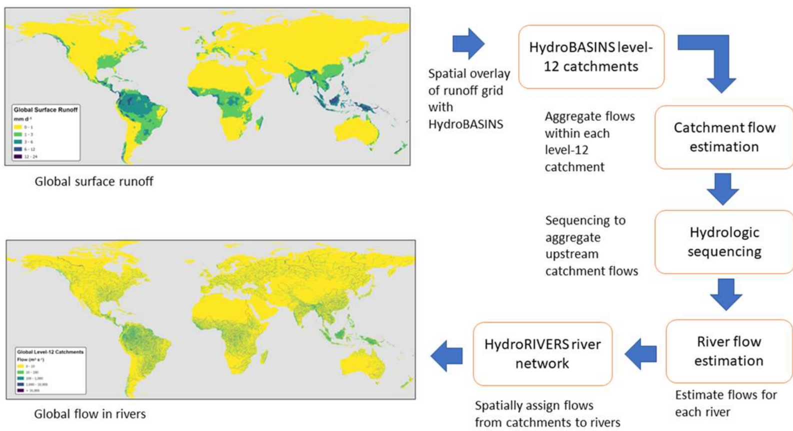
## Response:

(a) Thank you for your question and we realize that this can be clarified in the manuscript. A common spatial scale was needed to aggregate the sources datasets of differing scales. That is, the resolutions ranged from 250m to 1 km (more specifically: 250m for the Soil Hydrologic Group (SHG); 300 m for the Land Cover; 1 km for the precipitation data). These were all spatially downscaled (using the resampling technique) from their native resolution to 50m as a common denominator for the spatial processing as part of this work. This step was necessary to avoid loss of information from the source datasets by using a lower spatial resolution and to create a common grid for aggregation of the geographic datasets. 50 m was selected as a reasonable common scale for processing the data sets. We have also updated the text of the abstract and Figure 1 to clarify that the spatial resolution of the final data products are on a level-12 catchment resolution.

We clarified in the manuscript why we scaled down the original datasets to 50 m and how the geographic datasets were reaggregated and processed. The following text was added to **Section 2.3** in the **Methods**:

“The hydrologic soil groups, land cover and newly created annual mean daily precipitation gridded datasets were resampled by applying the nearest neighbor method (using the ‘resample’ function in ArcGIS) to a 50 m grid. This step was necessary to create a common denominator to process the spatial data. The 50 m interval was selected as a reasonable spatial scale to aggregate and process the source data sets."

We also agree with the reviewer that the 50 m gridding is not necessary for a global river dataset as the 50 m resolution was used to aid in the spatial processing of the source data for the run-off but was not used for the final data products. The 50 m grid run-off data was used as input to the river flows, which were aggregated up to the Level-12 catchment resolution. We have added the figure below to the discussion in **Section 2.4** to help clarify these processing steps resulting in flow at Level-12 catchments. Additionally, we have clarified in the text that the resolution of the flows are at Level-12 catchments.




(b) We agree and appreciate this comment since it helped us to better address the focus of the work and the novelty of our work. We addressed the reasoning behind the 50 m data processing and catchment scale aggregation in A1. The intent of this work is not improving the flow resolution compared to previous datasets, but to provide a flow dataset suitable for exposure model applications. We agree with the reviewer that this was not clear in the previous version of the manuscript, therefore we have made clarifications in the text as follows:

- We modified the Title to "Global river flow data for aquatic exposure models developed from surface runoff based on the Curve Number method" to further elucidate the target of the model.
- We explained in the introduction why the CN method was selected to simulate river flow and its advantages in exposure model applications.
- We removed the wording "50 m resolution" in the manuscript, since this created confusion, and replaced with "50 m sampling" / "50 m gridding" in the methods section and focus the language on the spatial resolution of the final product of flows at Level-12 catchments.

## Comment (2):

"*I would suggest the authors to further evaluate the interannual variation of the simulated river flows in this study using the observations. For such a dataset, it will be great if the scheme used in this study can capture the change trend of river flow. Otherwise, the datasets produced in this study seems to be not that useful*."

## Response:

We appreciate the suggestion of the reviewer and indeed this could be an interesting exercise as a follow-up to this work. However, the intent of the current model was not to provide a historical dataset of river flow but build a predictive approach suitable for simulating mean yearly flow, which is the metric used environmental exposure models globally across regulatory frameworks (for example in the European Union). An evaluation of the interannual viability of the flow was therefore out of the scope of this work, which also includes the evaluation of the approach, and thus exploring seasonable variability using this approach would be a natural next step for a future study. We have clarified the intended use of this flow dataset in the Introduction.

Additionally, we further addressed this point in the manuscript by introducing an **Uncertainties and limitations** section where we discussed this point:

- **Section 4.3 Temporal resolution:** discusses this limitation of the current model and potential next steps to add in temporal variation
- **Section 4.5 Implications for risk assessment:** Notes this as potential follow up.

## Comment (3)

"*Is it possible for the authors to compare the accuracy of river flows simulated in this study with existing global datasets of river flow? Are the results of this study more accurate than existing datasets?"*

## Response:

We have added clarifying text explaining why we chose to compare to measured gauge data rather than other flow datasets, such as FlO1K. The comparison with measured gauge flow data from GRDC was considered to be an optimal benchmark to compare the mean average flow dataset at the gauge locations as these are measured rather than predicted data. It is difficult to compare to other flow datasets at locations where flow has not been measured since it is unknown how accurate the flow predictions are for ungauged river segments. There are uncertainties associated with validating against global flow datasets for ungauged rivers since "accuracy" on those ungauged segments cannot be verified. Each river flow dataset has a different approach to calculating flow and contains their own uncertainties.

Thus, we chose to only evaluate our data against measured gauge locations and have added a sentence to clarify this in the manuscript in **Section 2.8**:

*"Although flow datasets are available in the literature at global scale (for example, the aforementioned FLO1K model (Barbarossa et al. 2018)), the flows at ungauged sites are estimated rather than measured, and thus this could introduce bias into the model evaluation as comparison are made to modelled values. Thus, the point-to-point comparison with measured flow at the gauge locations was considered the most appropriate benchmark to assess the performances of the model."*

## Comment (4)

"*I did not find any discussion on the uncertainties in the datasets produced in this study. The authors have calculated the surface runoff and river flow using the simple empirical CN equations, and the CN equations only consider land cover and soil type. However, many other factors, such as topography, dam/reservoir, irrigation, underground drainage and temperature, can also strongly affect river flow. I would suggest the authors to add some discussion on these factors*."

**Response:**

The authors agree that flow is variable and other factors will affect the river flow, and although based on empirical equations, the CN number method has the great advantage of requiring minimum input data, making it feasible for the application on a global scale. We agree that a discussion on limitations and uncertainties would strengthen the paper and we have added an "**Uncertainty and Limitations**" section (**Section 4**) in the revised version of the manuscript that addresses these limitations. This section addresses

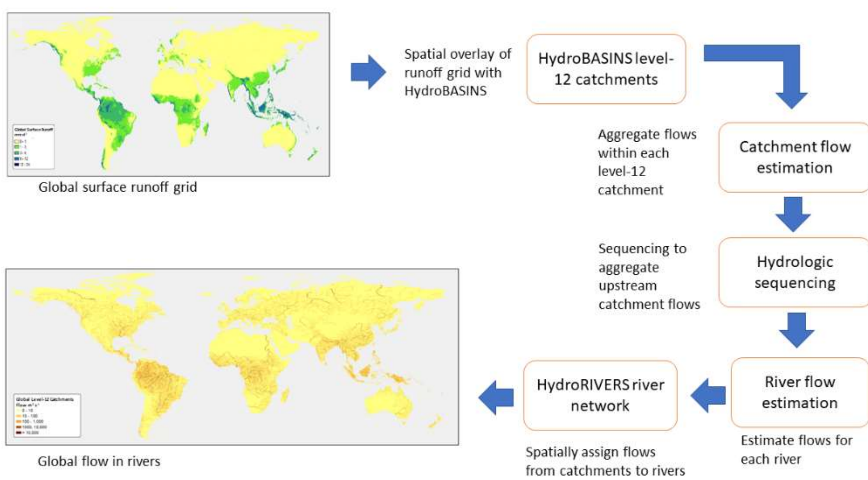
We have clarified the advantages of using the CN approach in the paper in in the **Introduction**, added discussion on processes that are not captured in the CN approach in the **Uncertainties and Limitation Section 4.4**, and added discussion on the implications of these assumptions and the applicability of the data for use in ecological risk assessment in **Section 4.5**.

### Comment (5)

"*In Figure 1, the authors have provided a nice flowchart to show the approach for calculating surface runoff. I would suggest the authors to add a detailed flowchart to show the approach for calculating the river flow based on the surface runoff, HydroBASINS and HydroRIVERS.*"

### Response:

We agree that a flow chart will help clarify the workflow. The flowchart below has been added to the manuscript.




### Minor Comments

***(1)*** *"L15 ** to create a global gridded dataset of annual mean surface runoff at a spatial resolution of 50 meters."*

**Response:** We have amended the sentence and the new sentence reads: "to create a global dataset of annual mean surface runoff."

**(2)** "*L160: how the monthly precipitation data is converted into daily precipitation rates? Did you assume the precipitation is evenly distributed in each month?"*

**Response:** We have added text to the manuscript to clarify how the daily precipitation rates were derived, as this indeed was not clear in the original text.
The following text has been added to the **Section 2.1.3 Precipitation:**

"As the CN approach to estimating runoff relies on daily precipitation, the monthly rainfall values were converted to a single daily rainfall, representing the average precipitation per day over the year, for use in Equation (2). To do this, a yearly average rainfall per month was calculated by summing the amount of precipitation per month (i.e. across 12 months) and then dividing by 12; which was then divided by 30 days to arrive at an average amount of precipitation per day."

**(3)** "*L225-280: Based on the description in sections 2.5, 2.6, surface runoff has been calculated for each day using Eq. 2. Why not produce the river flow rate for each day or each month?"*

**Response:** We used this approach as we were modeling for an average daily amount such that the precipitation within the runoff grids did not vary over time. Therefore, the surface runoff (and as a result, the flow) was not calculated for each day and thus did not vary over time. We recognize that this is not the traditional approach to derive the runoff with the CN method, since the CN equation has been developed using daily data.

We have also added in discussion of this approach in the uncertainty section.

Clarification text was added to the manuscript as follows in **Section 2.1.3 Precipitation**:

*"*As the goal was to produce average precipitation per day over the year, the precipitation within each grid did not vary over time using this approach. While rainfall intensity and total amounts of precipitation can vary daily, the purpose was to compute average total daily precipitation rates (inches per day) to predict average daily runoff in Equation. (2). As this is a simplifying assumption in the application of the CN approach, it may introduce some limitations in the flow predictions which are discussed further in Section 4. As part of future work, potential refinements can be implemented for specific geographies if spatially resolved rainfall data at daily scale are available.*"*

(4) "*Fig. 2: the unit of surface runoff in panel (a) should be mm d-1, and the unit of water flow in panel (b) should be changed to m3 s-1*"

**Response:** The units have been corrected and were changed on the figures in the revised manuscript.