

# Interactive comment on “The Kerala flood of 2018: combined impact of extreme rainfall and reservoir storage” by Vimal Mishra et al.

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Owing to the frequent flooding being reported at various part of the world it is of prime importance to study such events carefully to minimize the brunt of such calamities in future event. Though I do feel that topic is very interesting for the scientific communities working in the field of hydrology and climatology, I am also of the opinion that a sufficient in-depth diagnostic of this interesting case study is not up to the mark hence, does not provide the important facts and details comprehensively.

Thanks. As suggested by the reviewers, we have included a detailed discussion on the following aspects in the revised manuscript: 1) nature of extreme rainfall, 2) the role of simulated flow upstream of the reservoirs, 3) the role of reservoirs and their rule curves, 4) the influence of SST condition prior to the extreme rainfall. We feel that after including these aspects in the revised manuscript, manuscript will improve significantly to provide a comprehensive assessment on the Kerala Flood of 2018.

The authors mentioned the large-scale flooding in Kerala, India, during August 2018, which affected millions of people and caused 400 or more deaths. This shows heavy loss to human lives as well as the property. This Kerala flood event could be the worst flood of India (not only Kerala) in the century and may be well known globally by the scientific leaders working in the related research area. Here my concern is that, the manuscript does not provide any map/figure which shows a clear picture of disaster caused by climate change event or specific atmospheric phenomenon that triggered the event. The authors have provided only few statements mentioning about Kerala flood due to extreme rainfall event followed by the past flood events occurred in India. In my opinion, the research papers or technical notes should be scientifically sound than the articles available from electronic media. The manuscript should follow a holistic approach for better understanding to the scientific readers. Here, the authors should have provided the map showing the extent of flood or flood inundation for a better understanding of the readers those were not aware about this event. Moreover, this flood event as well as the extreme rainfalls occurred across all the catchments or Kerala state should have been compared with similar other events that took place in the past at other part of the India sub-continent in general and India in particular.

Thanks for your valuable suggestions. As mentioned above, we provide a discussion on the potential role of large-scale climate variability in the extreme precipitation using SST condition in the Indian and Pacific Oceans. However, we feel that if the event was caused by climate change or not, remains beyond the scope of this manuscript. We have no doubt that this is an important aspect and need to be studied. Our aim was not to compare this event with the flooding in the other parts of the region.

The representation of the study area is also very poor. The authors are explaining about the reservoirs but did not show the catchment of any of these reservoirs in the main document and rather put in the supplementary material. Besides, I could not find any major details of any of these reservoirs (such as how big they are etc.). I could not understand the purpose of showing Fig. 1c, where cumulative rainfall over whole Kerala state is presented. Showing cumulative rainfall over the catchment area of each reservoir would be a better approach that supposedly resulted in the heavy flooding in the selected catchments.

Thanks. We have included more details on the study area with the figure in the main manuscript. We provide a separate table on the details of the reservoirs.

The manuscript is also lacking the physical reasoning for the heavy flooding; and only statistical analysis has been presented in the manuscript towards extreme rainfall and reservoirs storage. Also it is very difficult to understand from the manuscript about the purpose of these dams/ reservoirs. Is the major purpose of these dams to control the flood or full filling the irrigation requirement of the state? It is worth mentioning about the reservoir operation. If most of these are flood controlling then, why were they failed

in controlling the floods? The authors should also explain these small but important facts to support the statistics resulted from the hydro-climatic dataset.

Thanks. As suggested by the other reviewers, we have included the analysis on the simulated flow and reservoirs operations (based on rule-curves) in the revised manuscript.

Due to lack of the information about this recent disaster event in the manuscript I tried to find more details on google for my own understanding. One of the report published in 'Down to Earth' discusses lack of emergency plan in about 61 dams however, the authors have selected only seven reservoirs. It will be very interesting for the readers, if the authors explain about the basis for selecting these seven reservoirs and why other dams are not so important and should not be the part of such analysis. It would also be interesting, if authors can show how the floods could have been prevented if these seven reservoir had been regulated properly leaving other 54 reservoir/dams.

We do not have observed data for all the reservoirs. Central Water Commission (CWC) provides observations for only seven major reservoirs located in Kerala. Therefore, we used only major reservoirs in our analysis. We have mentioned this in the revised manuscript.

The manuscript uses the IMD gridded rainfall product which is developed through Inverse Distance Weighting interpolation method using station based rainfall observations. Why the authors have used this gridded rainfall product which has interpolated information at  $0.25^\circ$ . In my opinion, the gridded rainfall may lose extreme information after interpolation. The use of station data rather than gridded products could strengthen the statistic obtained in the reported study. As the authors have not provided any details regarding catchment size of the selected reservoirs, it is difficult to figure out the geographical area contributing to the selected reservoirs; if the catchment area of these reservoirs is small authors should have used station data under each catchment instead of interpolated data at  $0.25^\circ$ . Also representation of the rain gauges locations in each catchment is also necessary. It is my humble suggestion to the authors to provide detailed information in figures to improve the clarity of the paper which will help the young scientists in better understanding.

We have added more information related to rain-gauge stations in the revised version. Moreover, we are trying to obtain observed rainfall data based on stations to compare with the gridded data. Long-term station based observations that are required for extreme value analysis are largely unavailable. Therefore, we used gridded rainfall data from IMD.

Furthermore, the present statistics are not sufficient enough to define this large scale disaster or we can say that there may be number of other reasons which were responsible for this heavy flood. The poor description of the actual process may mislead the future studies in-line this case study. I suggest the authors to use appropriate rainfall dataset, conceptualize the whole process and finally go for the concrete conclusion.

Thanks. We have revised the manuscript and provided more discussion. However, we can not evaluate all the aspects of flooding due to data limitations, which has been mentioned in the conclusion section.

The authors can take the help of some well-established hydrological models for physical understating of the whole hydrological process.

Thanks. We have used SWAT model to simulate the daily flow upstream of major reservoirs.

Overall, the topic is very interesting and eye caching but manuscript does not lead to any scientific advancement. "Hydrology and Earth System Science" is reputed in the scientific community for publishing technical notes/report with new developments, novel

approaches, and techniques relevant for scientific investigations, however this manuscript fails to present any scientific advances in terms of theoretical methods or techniques. Therefore, I request authors to kindly take notes of the comments and revise the manuscript accordingly. I strongly believe that this study has the potential of becoming an important piece of work once it is revised properly considering all the facts and details.

[Thanks for your constructive comments.](#)