Reply to Referee Comments-1

We would like to sincerely thank the referee for their valuable comments and constructive suggestions. The feedback provided has been instrumental in improving the clarity and depth of our manuscript.

What is the novelty of this paper? Several studies have already been conducted on this topic.

Reply: Though there are similar works done, the novelty of this work lies in the development and application of a comprehensive, automated framework for floodwater delineation and depth estimation using EOS-04 (RISAT-1A) SAR data and Digital Elevation Models (DEMs). This is the first study to apply the established Automatic Tile-Based Segmentation method and the Height above the Nearest Drainage (HAND) tool to EOS-04 data for flood extent delineation. Integrating the proposed method along with the Trend Surface Analysis (TSA) method for flood depth estimation eliminates the need for extensive input data required by traditional hydrodynamic models. The TSA method, capable of generating accurate flood surfaces using only inundated water layers and DEMs, is particularly innovative in its ability to adapt to varying spatial trends and elevation changes in large and complex river systems and efficiently perform in highly flood-affected study areas of India. Furthermore, the incorporation of public and fine-resolution DEMs based on terrain type ensures adaptability and precision in both plain and steep areas. The study also addresses common challenges in SAR data analysis, such as hill shadows, by effectively leveraging the HAND tool to eliminate false water areas. Validation of this methodology derived flood depth against field-measured data and comparison with the Floodwater Depth Estimation Tool (FWDET) demonstrates its superior accuracy, with lower RMSE values, highlighting its potential as a robust, efficient, and scalable solution for real-time flood assessment.

The methods are purely used to reconstruct historical floods. However, the manuscript becomes more impactful if it could be associated with storm characteristics like storm magnitude and return periods to generalize it for future applications. These will provide the probable extent of a storm event with a specific return period.

Reply: As noted in the comments, hydrological and hydrodynamic studies often face challenges due to insufficient and unsuitable data across various terrains. Storm and rainfall events can occur in different areas, impacting administrative units with data limitations. The methods in this study focus on reconstructing historical floods through floodwater delineation and depth estimation. Integrating storm characteristics, such as magnitude and return periods, would enhance the framework's ability to predict future flood scenarios. By linking flood extents and depths with diverse storm events, this methodology could provide probabilistic flood maps for specific return periods, improving decision support for disaster preparedness.

Hydrodynamic models are indeed time- and data-intensive but capable of handling the limitations of the approach raised in this manuscript. This approach is probably effective in flood extent and depth estimation but not sure about its skill on other hydrodynamic characteristics of the flood, e.g., flood velocity. Is it possible to include this property in your analysis?

Reply: The presented approach is designed to efficiently estimate flood extent and depth with minimal data requirements, addressing challenges such as SAR data limitations and terrain-specific

DEM resolution needs. While hydrodynamic models can simulate additional flood characteristics, such as velocity, they require extensive input data and computational resources. Incorporating flood velocity into this framework is theoretically possible but would require additional data, such as flow rates and channel properties, and potentially adapting or integrating simplified hydrodynamic modelling techniques. Future work could explore combining this methodology with complementary tools or datasets to estimate flood velocity and other dynamic characteristics, enhancing its scope. However, the primary focus of the current approach is on rapid flood assessment with practical applicability, prioritizing efficiency and accessibility over the detailed outputs of traditional hydrodynamic models.

It is encouraged to specify the limitations of your results in real-world applications and indicate what kind of flood management decisions can be made confidently. This will provide confidence to end-users.

Reply: The presented approach has some limitations in real-world applications. One of the key challenges of the flood extent method is its occasional misinterpretation of high-moisture areas as flooded regions due to the radar's sensitivity to water content in soil. Additionally, the method performs optimally when the entire satellite scene is captured under the tile-fitting framework, ensuring comprehensive data representation. Similar limitations exist when estimating flood depth. First, the accuracy of flood depth estimation is sensitive to the resolution and alignment of the DEM with the flood layer, particularly in steep terrain, where high-resolution DEMs are essential which is taken care during the selection of satellite datasets and derived flood layers. Second, while the methodology effectively delineates flood extent and depth, it does not account for hydrodynamic characteristics such as flood velocity or temporal variations in flood behaviour, however, the information generated through the proposed approach is of great help in real time relief and rehabilitation, rescue operations in the field. Third, the approach performs best in areas with gentle slopes and may other complex terrains can be handled with slope / land use information in a contextual referencing approach. Despite these limitations, the results are highly reliable for flood extent mapping and depth estimation in plain and moderately sloped regions, enabling decisions such as identifying flood-prone areas, prioritizing evacuation zones, and planning resource allocation for relief and rehabilitation. The rapid and automated nature of the framework makes it suitable for near real-time flood assessment, supporting emergency response efforts. The management decisions, especially during the relief and rehabilitation activities and rescue operations can be made efficiently in terms of deployments of rescue materials like boats/ type boats, and suitably skilled manpower, End-users can confidently use this tool for planning mitigation strategies, such as floodplain zoning and infrastructure protection, while recognizing its constraints in predicting dynamic flood behaviours etc

In section 4 of the manuscript, results are presented but the discussion part is missing, which is important to connect your results with similar previous studies.

Reply: Thank you for feedback. We will update in the revised Manuscript.

Minor Comments:

Indicate permanent and seasonal water bodies in your study area (if any)

Reply: **In our study area, we have identified both permanent and seasonal water bodies. These features have been incorporated into our analysis, as they can influence flood behaviour and hydrological patterns. We will ensure to clearly indicate these water bodies in the revised manuscript.**

Improve the quality of Figure 10, legends are not readable

Reply: **Corrected in the Manuscript and will be updated through revised manuscript.**

Put table titles consistently before/after the table

Reply: **Corrected in the Manuscript and will be updated through revised manuscript.**

Correct grammatical and punctuation errors (missing spaces between words, inappropriate use of full stops, colon, etc.)

Reply: **Corrected in the Manuscript and will be updated through revised manuscript.**

Reply to Referee Comments-2

The paper presents a method for estimating the depth and extent of floods from SAR imagery. Since SAR data are already widely used in the literature for flood monitoring, it would be helpful for the authors to highlight the differences between their approach and existing ones, clearly highlighting the strengths and any limitations. In addition, it is suggested that the authors describe the method in greater detail and clarity so that it can be easily understood and used by a wider audience. The following are additional specific suggestions for improving the quality of the work:

Reply: **Thank you for your valuable feedback. We appreciate your suggestion to provide a clearer comparison between our method for estimating flood depth and extent from SAR imagery and existing approaches. We also acknowledge the need to describe our method in greater detail and clarity to ensure it is easily understood and usable by a wider audience. It will be updated in the revised manuscript.**

Line 16: It would be good to make explicit what is meant by the term “lower” and also include numerical performance results for clarity. This would help to better understand the effectiveness of the proposed method.

Reply: **The numerical performance results are presented in Section 4.2.3 (Validation of Results), where the RMSE for the Trend Surface Analysis (TSA) technique is reported as 0.805, compared to 5.23 for Flood Water Depth Estimation Tool (FwDET) Technique. To enhance clarity and address your suggestion, abstract from line 15 is improved like this “Water levels estimated at river gauge stations using the TSA technique are validated against real-time field measurements and compared with results derived from the Floodwater Depth Estimation Tool (FwDET). When evaluated relative to gauge station water levels, the TSA technique demonstrates a root mean square error (RMSE) of 0.805, significantly lower than the RMSE of 5.23 observed for the FwDET”.**

Lines 40-49: It is recommended to revise the text and punctuation in these lines in order to improve fluency and clarity. Some sentences are indeed a bit complex and could benefit from restructuring.

Reply: **Thank you for valuable suggestion. We have addressed your comments and will update in manuscript. The revised text now reads as follows (lines 40-49): "Additionally, cyclone-prone states such as Odisha, Andhra Pradesh, West Bengal, and Gujarat have necessitated the preparation of Flood Hazard Zonation Atlases, collectively accounting for 10 million hectares of flood-affected areas. This highlights the critical need for real-time flood mapping and monitoring, the implementation of automated flood mapping techniques, and the generation of accurate spatial flood depth information to support disaster management efforts in these regions.**

Satellite data and flood inundation information are widely used for near real-time mapping and monitoring of flood events (Rizwan Sadiq et al., 2022). Ensuring accuracy in flood extent and depth is critical, as this information is essential for effective relief and rehabilitation efforts in the field."

Lines 110-111: It is necessary to better specify what is meant by "limit within the active channel." This should be clarified to avoid ambiguity and allow a more precise understanding of the method.

Reply: **Thank you for the suggestion. Statement in lines 110-111, 'Additionally, FwDET's floodwater depth accuracy is poor in the case of active channels,' has been removed to avoid confusion during reading. However, the following line, 'To overcome this limitation, this paper introduces a novel method called Trend Surface Analysis (TSA) to improve the accuracy of flood depth estimation,' is intended to emphasize the novelty of the Trend Surface Analysis (TSA) method in enhancing flood depth estimation accuracy."**

Line 117: The case studies should be described in more detail, including information such as the size of the watersheds and the physical and hydrological characteristics of each. In addition, it would be helpful to add a picture showing the watersheds in relation to the closure sections to enhance visual understanding of the context.

Reply: **Thank you for the feedback. The TSA technique used in this study is not dependent on the watershed but rather on the slope and height of the terrain. The method relies on how water interacts with the landscape based on the terrain's incline, which directly influences the accuracy of flood depth estimation.**

Line 133: It is important to explain the reason why satellite images with different spatial resolution (e.g., CRS and MRS) were used. Also, it would be helpful to clarify what the temporal resolution of acquisition of these images is, especially in relation to the five types of spatial resolution used.

Reply: **Satellite images from multiple sensors are acquired based on their orbital coverage over the study area during the flood event. To ensure higher observation frequency, data from CRS/MRS sensors is utilized when available. The layers selected from these sensors are independent of the temporal resolution.**

Line 142: It would be helpful to know how many level measurements were extracted from the CWC site. It is suggested that these measurements be reported in a graph or table for clearer and more immediate visualization.

Reply: **In this study, we employ a single water level measurement from each CWC river gauge site, corresponding to the exact date and time of the satellite acquisition for the study area. For instance, in the Andhra Pradesh study area, satellite imagery was captured on 28th July 2023 at 18:00 hrs. At this precise time, the CWC team recorded the water level measurements for the relevant gauge sites in the study area. A table has been created as per suggestion, and it will also be updated in the manuscript.**

S.No	Water Gauge Station Name	Field Measured Water Levels
ANDHRA PRADESH		
1.	Kunavaram	41.02
2.	Koida	39.72
ASSAM		
1.	Beki Rd Bridge	44.92
2.	Pangladiya NT Road Xing	52.84
3.	Pandu	47.25
4.	Guwahathi	48.19
BIHAR		
1.	Baltara	34.9
2.	Kahalgaon	31.08
3.	Azamabad	30.54
4.	Kursela	29.98
UTTAR PRADESH		
1.	Dabri	137.18
2.	Fathegarh	137.78
3.	Kannauj	125.67
4.	Bewar	138.32

Lines 155-185: The authors should explain in more detail the workflow illustrated in Figure 3. In particular, it would be useful to supplement the figure with a textual description that would allow even readers who are not experts in the field to understand the methodological choices made, as well as how the process was replicated.

Reply: **We appreciate the reviewer's suggestion to provide a more detailed explanation of the workflow presented in Figure 3. We will update in the revised manuscript.**

Line 274: It is recommended that the Landsat images used to validate the method be introduced in the paragraph devoted to the data used. This would allow for better contextualization of the data and their use in the validation process.

Reply: **Thank you for your helpful suggestion. We will include details in the revised manuscript about the source of the Landsat images, their relevance to the study, and how they were used in the validation to ensure better clarity.**

Line 275: It would be appropriate to run the validation on a larger number of dates and create a confusion matrix comparing water and non-water areas. This would allow for a more accurate assessment of method performance. In addition, it would be useful to calculate other performance metrics such as accuracy, precision, and recall to provide a more complete evaluation.

Reply: **Thank you for your valuable feedback. The primary focus of this paper is on flood depth estimation. As such, the automatic tile-based segmentation method is not the central point of this study.**

Discussion: The discussion section lacks a comparison with other work in the literature. Authors should highlight the strengths of their method compared to what has been proposed before, pointing out any significant innovations or improvements.

Reply: **Thank you for feedback. We will update in the revised Manuscript.**