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Title: Earth observation informed modelling of flash floods
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MS type: Research article

Review 2 - egusphere-2024-2722

We thank the reviewer for taking the time to evaluate our manuscript. We have addressed the points raised below in bold.

I found the manuscript to include several interesting elements, but I struggled to grasp a clear central message. It seems to be trying to do three things at once: (1) demonstrate how NDVI-based satellite observations can be used to support flood model validation in data-scarce areas, (2) compare three flood models of different complexity in terms of their performance and efficiency, and (3) simulate future flood hazard under changing climate conditions. All of these are relevant and useful topics, but the way they are presented together in the same paper feels unfocused. It's unclear which of these is the main contribution.

The title emphasizes "Earth observation informed modelling," which suggests that the novelty lies in using NDVI (and potentially other EO data) to support flood model validation where traditional in-situ observations are unavailable. This is potentially a very valuable idea and an important contribution. However, the paper spends a lot of time comparing three models and running future scenarios, and those parts — while well executed — feel somewhat disconnected from the core innovation. If the goal is to highlight the value of NDVI as a validation tool, then that angle needs to be brought forward much more clearly, both in the framing and the discussion. If, instead, the authors are more interested in benchmarking models or demonstrating a future risk pipeline, then the paper might need a different title and narrative altogether.

As it stands, the paper tries to be a methods paper, a modelling comparison, and a climate risk study all at once — and as a result, the reader is left unsure what the takeaway is. I would encourage the authors to clarify their core message, streamline the structure around that message, and remove or reduce content that is not essential to it. A more focused version of this study could be very publishable, but in its current form I would recommend substantial revision and resubmission.

We understand your concern that including a NDVI analysis, flood model comparison, and climate change analysis has potentially resulted in an unclear core message and takeaway from the paper. It was always our intention to include each element to demonstrate how the earth observation data (NDVI change) could support flood hazard modelling in data sparse regions, such as our chosen study site. Therefore, we used the NDVI analysis in an applied research perspective to evaluate three flood models in the absence of traditional calibration data (e.g. river gauge data). This could then inform a future flood risk assessment using a climate change analysis. We believe this integrated approach is in the scope of the journal but fully agree that we need to present a clear aim and coherent discussion throughout the paper. Focusing on one of the elements for multiple case studies, for example deriving reference flood extents using the NDVI differencing approach, would be a valuable analysis. However, in

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our application in a data sparse flash flood region, we only had a single historical flood example to draw upon. Therefore, we prefer to clarify the importance of our integrated approach and remove unnecessary detail, rather than focussing the study on one element.

We propose the following changes to clarify the core message and remove non-essential content:

- **We have modified our aim and objective to clarify the link between each element of the manuscript, and explicitly include mention of the NDVI differencing:**
    - **'*In this study, we aimed to draw on our experience in the application of the DSE in Nablus, Palestine, to evaluate how satellite data can be used to inform flood hazard modelling in data sparse flash flood regions through the development and implementation of an end-to-end methodology. Our objectives were to: (1) delineate the flood extent of a major historical flood using NDVI differencing applied to pre- and post-flood satellite imagery; (2) evaluate the performance of three flood hazard models of increasing complexity against the observed flood extent; and (3) apply the validated flood models to inform an assessment of current and future flood hazard in the region. We aimed to create and apply an end-to-end methodology to assess flood hazard.*'**
- **We have modified the introductory text under '3.3 Rainfall data and climate scenarios' and '3.4.1 January 2013 flooding' to clarify how these sections link to the overall analysis.**
    - **'*Historical and future projected rainfall data were used in a climate change analysis to demonstrate how satellite analysis of the observed historical flood event could inform a future flood hazard assessment.*'**
    - ***'Three models were used to simulate the January 2013 flooding and evaluate their accuracy with respect to the historical flood extent'***
- **Additional text was included under '4.1.1 NDVI change' in response to Reviewer 1, which expands the discussion on the method and its limitations.**
    - ***'…and lower detection of NDVI changes for channels in built-up environments due to sparser vegetation coverage. Therefore, using NDVI change to derive reference flood extents would not be appropriate in urban areas; however, the deposition of sediment in these areas could be used instead if they had sufficient spectral contrast to the surrounding roads and buildings (Notti et al., 2018).'***
    - ***'Non-fluvial NDVI change represents a vegetation response to the storm precipitation or standing water. These areas may still drain into lower order streams but are unlikely to be associated with main channel flooding.'***
- **We have removed part of the discussion about the climate models to streamline this section:**
    - **'Downscaling methods add to the uncertainty of future climate projections (Teng et al., 2012). Quantile mapping, which has showed better performance for bias correction of stationary data (Heo et al., 2019) was used in this study to correct the systematic biases of the GCMs. Here, the distribution of observed**

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data is transferred to the projected values. Therefore, the quality of observed data also influences the biases in future climate uncertainty.'

- **We have moved Figure 8, the rainfall data and bias correction, to the supplement, since this supports the climate analysis but the detail is not required in the main text.**
- **We have modified text in the conclusion to mention the NDVI differencing approach:**
    - ***'In this study, we used pre- and post-flood satellite imagery from an extreme rainfall event in January 2013 to map the associated inundation extent and impacts in the northern West Bank, Palestine using an NDVI differencing approach'.***
    - ***We have reordered and modified the text to finish the conclusion with:* 'Our study demonstrates the value of high-resolution multi-spectral satellite observations to derive flood extents through NDVI differencing following a flash flood, which then supports model calibration in data scare regions lacking other hydrological observations such as gauging stations, or where post-event mapping of flood characteristics is not available.'**