

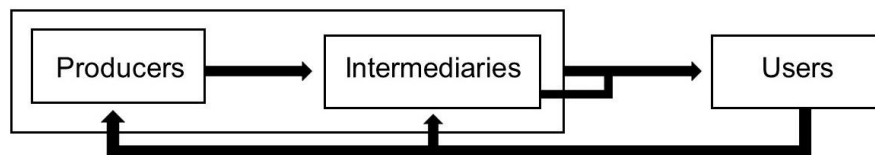
RESPONSES TO REFEREE #2

The paper highlights and responds to a gap in research on the process of developing forecast bulletins for decision-makers i.e. professional, institutional users. It includes many practical and helpful insights from the process, as examined in two different cases.

Some comments and suggestions are given below:

- 1. Context: Consider using diagrams/figures to concisely convey the various flows of information and stakeholder relationships (Users, Intermediaries and Producers) for clarity.**

We have added the following diagram to the paper with the accompanying citation to improve clarity. It has been added after line 64 where the paper outlines producer, intermediary and user roles. It has been cited within the paper at line 64 (Figure 1).



“Figure 1 Diagram indicating common relationship patterns between the roles of producers, intermediaries and users in bulletin development and production. Arrows indicate typical flows of information.”

All figure numbering has been updated to include this figure.

- 2. Methodology: The choice of cases appears to be fairly pragmatic and the methodology would benefit from further explanation and justification of the choice and the implications for the subsequent analysis.**

We have added the following text to the Data and Methodology section at line 270.

“The choice of the case studies was based on the authors involvement within the SHEAR programme. The authors of this paper have occupied various roles within the SHEAR programme including: consortium members in the LANDSLIP and FATHUM projects; team members involved in the development of the bulletins; and/or acted as Knowledge Brokers of the SHEAR programme. In the process of carrying out these roles, the authors witnessed challenges, and commonalities and differences between approaches and solutions for each case study and identified these examples as presenting an opportunity for learning about the process of developing bulletins from those who were involved.”

The following paragraph in the submitted paper goes onto outline the opportunities this provides and also outlines the efforts the author team have made to ensure the results are based on the data gathered and limit biases within the authorship team.

“The authors of this paper bring a range of roles and a unique dual perspective to these case studies, bringing together core team members of both case studies (bringing an insider perspective), alongside those outside of the core projects who have engaged with those initiatives and teams over several years as Knowledge Brokers of the wider SHEAR programme (bringing a semi-outsider perspective). The authors have made efforts to focus reporting of the results directly from the data sources, ensuring all perspectives are represented, whilst also reflecting on useful learning during the discussion section, to bring in their unique position and experiential knowledge.”

- 3. Results: A strength is the level of detail and granularity provided in the results section. Giving specific examples, for example the choice of words or colours, transparently allows the reader to see into the process of co-production and development of bulletins and means that these insights are not lost in over-generalisation. However, I think that consistency and signposting of when you are writing about which case and the similarities and differences, could be improved for clarity. Consider whether summary tables could be helpful.**

The authors have checked through the paper and edited sentences so that it is clearly stated which case study is being described (using cyclone or landslide as the distinguishing characteristic for consistency).

We have also added in the following table in section 5.2 Bulletin content (line 333):

“Table 3 summarises some of the key features and changes to the cyclone and landslide bulletins, which are described in more detail in the following sections.

Table 3 Key features and changes to the content of the bulletins, including layout, text, visuals, and information.”

Content	Both	Landslide bulletin	Cyclone bulletin
Layout	Summary information at the beginning. More detailed information provided later.	Evolved from 1 page to 2 pages. First page providing changing information, second page containing static information.	Cyclone Idai bulletins evolved from 9 pages to 13-15 pages, as new information added. Cyclone Kenneth bulletins evolved from 5 pages to 10 pages. Summary information as bullet points on first page.

Text	<p>Simplification of terminology.</p> <p>Reduction in the amount of text provided.</p> <p>Text accompanying visuals to explain them.</p>	<p>Text descriptions of each day’s forecast provided instead of levels of warnings.</p> <p>Changed title from “warning” to “forecast” and “experimental” added.</p> <p>Forecast level terminology changed from [Widespread (most places); Fairly widespread (many places); Scattered (a few places); and Isolated] to [Less likely; likely; more likely; most likely] then to [Very high; High; Moderate; Low].</p> <p>Terminology explanations provided in key.</p>	<p>Update section added, summarising changes since last bulletin on first page.</p> <p>Summary first page layout edited to be easier to read.</p> <p>Methodology section removed (remained available as static information).</p>
Visuals	<p>Labelling of key places (particularly if mentioned in text) and administrative areas onto maps.</p> <p>Increase in the number of visuals (maps and graphs) with keys and supplementary text.</p>	<p>Removal of weather forecast maps and focus on landslide forecast maps.</p> <p>Forecast key colours changed to IMD traffic light colour system.</p> <p>‘Spots’ of colour added to maps where warning level is higher/lower than assigned administrative level.</p> <p>Changed to freestyle shapes.</p> <p>Landslide susceptibility map and text included on second page. Changed to greyscale, then to red tones.</p>	<p>GLoFAS colour scheme changed to traffic light system.</p> <p>Map of area focusing on added to first page.</p> <p>Various maps and graphs added: flood hazard map; graph of temporal forecasts from ECMWF; probability of exceedance of severe flood level; timeline of observed flood extent maps</p> <p>Satellite imagery maps added then removed.</p> <p>Simplification of graphs and maps.</p>
Information	<p>Evolving content of type of information.</p> <p>No advice included.</p>	<p>Warning, vulnerability, impact and action content removed.</p>	<p>Evolving to include three main pieces of information: 1) meteorological forecast; 2) flood forecast; and 3)</p>

		<p>Important information section added to second page with information on uncertainty and caveats/limitations.</p> <p>Added disclaimer in red text below title.</p> <p>Rivers and roads added to static maps.</p>	<p>flood hazard and population exposure information.</p>
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4. *Second paragraph of 5.3 Information vs. advice - seems to be more about complexity. Is this a theme in itself?*

The authors reflected that this second paragraph was a previously identified separate theme on complexity that was merged with the content on information and advice as it is a linked topic. We have separated these topics back out by inserting a separate sub-title for the second paragraph (5.4 Communicating complexity). Section numbering has been updated to reflect this addition.

This topic is also mentioned at multiple stages of the paper, so the authors suggest there is not a need to include anything in addition to the current dialogue. For example, complexity is discussed in the following sections: abstract (line 18), literature review (line 134), results (line 402), considerations (line 666) and conclusions (line 752):

“Both case studies experienced challenges dealing with uncertainty, complexity, and whether to include advice.”

“A multitude of factors make the development and communication of understandable and actionable forecast information incredibly complex, with complexity in the hazards themselves, alongside complex social, political and economic contexts.”

“Given the complexity of the information being provided in the graphics, and the range of possible interpretations of visual information, explanatory text was deemed essential by producers and intermediaries (and from user feedback) to enable end-users to understand the context and meaning of the maps and colours in the bulletin.”

“Where this understanding and appreciation of added value was lacking to begin with (in the case of some physical scientists), it evolved over time as pressures to operationalise bulletins increased awareness of the importance and complexity of communicating useful information to users.”

“Key challenges from the case studies included: meeting user needs supported by strong science; communicating complex information (including uncertainty) clearly and effectively; and the limited time during crises to make changes and respond to feedback.”

5. Considerations: This more discursive section aims to bring together insights from the results for others developing forecasts and bulletins for natural hazards. A topic of importance that I feel is not adequately addressed is that of accountability - who (among all stakeholders - producers, intermediaries and users) is ultimately accountable for the information provided and its impacts? And how has this been considered throughout the bulletin development process?

This topic is partially covered in section “6.3 Meeting user needs” (line 690). The authors recognise accountability is an important topic, so suggest moving the paragraph from line 690 to a new section “6.4 Mandates and responsibilities” and editing the text to the following content. Section numbering has been updated to reflect this addition.

“There were tensions in both studies between balancing science and user needs not only because of what is possible for scientists to provide, but also influenced by tensions related to the mandate and purpose of science and scientists (specifically physical science forecasters), and also by the aims, scope, and restrictions of funded projects. In both studies, there were challenges related to users requesting information that was beyond the scope of the project, for example, the inclusion of exposure, impact, and vulnerability data or assessments which could be used to influence actions that affect people’s lives.

The official responsibilities of producing forecast information were different for each project. The cyclone bulletins were produced by non-responsible institutions at the request of a key stakeholder. As such one of their main focus points was to ensure scientific rigour in the information they provided, to protect institutional reputation, but they were not officially responsible or mandated with providing the information - it was supplementary to formal mechanisms and information.

For the landslide bulletins, this was more complex as the project lifetime covered a period when the institution that would undertake production of bulletins beyond the project funding was undergoing a major shift in their institution’s role and official mandate during the project lifetime, changing from their previous focus on response to landslides towards the provision of information in advance of landslides. This change in mandate required a significant institutional culture shift and a rapid learning curve to overcome the initial lack of experience, familiarity and confidence in issuing forecast information.

Landslide project interviews highlighted the impact of institutional mandates and responsibilities on the bulletin, emphasising that the producer’s responsibility was to provide forecast information, and not to issue warnings. This directly affected the content of the bulletin: the terminology of “forecast” rather than “warning” was carefully chosen, it was decided not to provide (or update) vulnerability information in the bulletin, and it was decided not to provide advice on actions to be taken in response to warnings.

In published literature and real-world examples, there is a tension in not just what science can provide, but whether they should provide it at all. This comes to the fore particularly when science is used to make decisions alongside other evidence (Frick and Hegg., 2011). When these types of decisions are the role and responsibility of government officials, but need to be informed by science, then scientists need to be careful in considering what they provide, how they provide it, and how to communicate it (Kox et al., 2018). There needs to be a clear and transparent agreement and awareness of the difference in roles, responsibilities, and mandates of the producers of forecasters compared to that of the institutional decision-makers (Sukhwani et al., 2019). This is vital in developing and protecting forecast producer's scientific reputation and the users' trust in their abilities.”