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Interactive comment on "Brief Communications: Observations of a Glacier Outburst Flood from Lhotse Glacier, Everest Area, Nepal" *by* David R. Rounce et al.

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This manuscript presents the results of opportunistic observations and measurements conducted around the Lhotse Glacier during and after a glacier outburst flood in the pre-monsoon season of 2016. The aim is to provide some insight into the magnitude of the event and the processes that triggered the flood as well as controlled the progression of flood waters through the supraglacial and englacial hydrological systems. Field observations are supported by some basic satellite image analysis, and the main conclusion of the work is that there is still much to be learned about these rarely observed events. This holds true even for this manuscript; as the reader I was not entirely sure what I had learned at the end of it other than the basic information relating to the

flood. Nevertheless, given that such events are very rarely observed in real-time, I am strongly in favour of the observations being published. I do have several suggestions that may strengthen the manuscript further, and some less major comments that the authors should address.

Major comments

The main deficiency of the submission is that no substantial conclusion relating to the source or trigger mechanism of the flood can be reached based on the data that are presented. Three additional analyses may provide some further illumination:

1. Can you explore the satellite image archives (even just Google Earth) to see whether the large supraglacial pond (at D in your Figure 1) has persisted over several years, or whether it was a new feature in the build-up to the flood? If it was new, it lends support to your interpretation that the flood was related to recent meltwater storage, possibly from a blockage in the englacial system, with the pond representing the surface expression at the head of the stored water. If it is not new, then this interpretation is less likely to be valid. Its disappearance would point more towards more 'normal' drainage as the pond intercepts an englacial channel. If you integrate these observations with the next suggestion, you might at least be able to say with more certainty whether the water was supraglacially or englacially sourced.

2. Can you use your rough estimates of discharge to back-calculate a conservative overall flood volume? Clearly there will be large uncertainty associated with the calculation, but it may be sufficient to rule out the simple drainage of one or two supraglacial ponds if, as I suspect is the case, the overall flood discharge exceeds what you might reasonably expect the combined supraglacial pond volume to be. Then you might be able to say with some certainty whether water was being stored beneath the glacier surface.

3. Are there any reports from locals about the shape of the hydrograph? Or are your own observations sufficient to say anything about that? On page 7, line 11, the

text states that the flood had sudden onset. If so, this implies that there was a sudden failure of the dam rather than something more gradual like surface water tapping into an inefficient hydrological system. If even a crude hydrograph shape can be reconstructed it may help you at least narrow down the flood trigger.

I suspect that one or more of these extra analyses will allow you to rule out a few hypotheses, even if they don't get you to a conclusive interpretation.

Minor comments

P1 Abstract: this needs some work. The abstract should summarise what was done and what was found out.

P1 26-27: isn't the lack of attention simply because these floods are so unpredictable and thus rarely observed?

P2 3-6: these are a mixture of cause (triggers) and effect of drainage. Channels becoming progressively enlarged, for example, are not a cause of floods. They are possibly a control on the discharge, and are certainly more of an effect of the flood than a cause.

P2 15: insert reference regarding mass loss

P2 20: are subsurface and englacial not the same thing?

P2 27: worth mentioning here that Lhotse is one of the few glaciers in the region without a steep bounding terminal moraine (i.e. that might trap or at least modulate flood waters in other locations)?

P3 9 (and elsewhere) is it Chukung, or Chukhung? I've seen both, but I think the latter is more common?

P3 11: replace 'accounts for' with 'comprises'?

P3 14: missing 'the'

P3 22: missing 'the'

P4 20: 'retrospectively?

P5 20: can you give an idea of the pond size? Just its rough diameter as measured from the satellite data would be helpful

P6 6-7: change to 'was not possible due to. . .'?

P7 3-4: I'm not convinced your observations reveal anything about the triggers in the current version of the manuscript so you might choose to rephrase this sentence

Figure 3: can you indicate the scale that is shown here?

P7 11-13: what does this sentence actually mean? That hydrofracture was the cause? Or that a dam was breached? And what is the evidence? If you are suggesting that the englacial hydrology was blocked then you need to state this more clearly.

P 7 11: was the outburst definitely sudden? If so, you have evidence of dam failure and you may be able to infer something more about the trigger than you already have.

P7 18: do conduits 'rupture' in this way? I'm not familiar with this if so. . .

P7 19-20: wouldn't a simpler explanation be that the englacial system was overwhelmed so the water found another (i.e. surface) route?

P7 10-22: It might be helpful to separate out the discussion of the triggers vs subsequent processes as they are very different.

P8 1-2: the increase in discharge is more likely to be related to the ability of the developing channels to convey water, don't you think?

P8 3: what do you mean by meltwater storage in this context? Englacial specifically? Can you clarify?

P8 13-16 this process is not normally sudden. I think you have to invoke a slightly different chain of processes.

P8 22: I don't think this is likely to be true. Partly it depends on what you class as a scientist (locals can also be 'scientists') and many 'scientists' have been working in the Himalaya for many years. I suggest removing this statement as it is not necessary and it is unsubstantiated.

P8 23: as the manuscript is presented I don't think you shed any light on the triggers, so you might want to modify this.

P8 26-27: do you mean the difficulty of making interpretations on limited data highlights the lack of knowledge? Can you clarify?

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