

## ***Interactive comment on “Estimating lateral moraine sediment supply to a debris-covered glacier in the Himalaya” by Teun van Woerkom et al.***

**Anonymous Referee #4**

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### General comments:

The hypothesis stated on page 3 of the manuscript proposes that lateral moraines can play an important role in supplying the glacier tongue with debris, especially for glaciers that are stagnating and the tongue is disconnected from the headwall. The goals of the paper are to quantify erosion rates across a 5-year period by using high-resolution DEMs. The dataset provided by this paper is remarkable, very high resolution and from a remote location whose future demise will wreak havoc on downstream communities. This large, alpine glacier undoubtedly warrants current research and the negative feedback cycle created by debris insulating the glacier tongue is an understudied process.

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Overall, I find that the study is both overly complex and overly simplified at the same time. To improve the manuscript, the authors could remove some datasets, such as the clast shape analysis, as the population of clasts sampled seems far too small to gain any interpretable insights. This would remove the field-based component of the manuscript, but I don't think that would weaken the paper. On the contrary, I think the paper could be strengthened by using only the remotely sensed data. The authors present many erosion rate calculations for different sections of the moraine, but they never use those data to predict how long (in years, e.g.) it would take for the glacier tongue to remove a certain amount of debris. Although not part of the manuscript in its current state, I think the manuscript could be improved if the authors added a predictive component to their research, like answers questions such as: if the debris cover is adding a negative feedback to the glacier ice, will the debris allow the ice to persist past the year that the glacier ice is expected to melt? And if so, by how many years? At what time point would the lateral moraines deflate enough so that they are not contributing debris to the glacier tongue?

Apart from the technical issues I present below, I find that the authors use the term 'erosion' in a misleading way, and could replace it with 'transport' in some situations. Erosion implies that the material is carried away from the glacier system, as opposed to being transported to lower on the glacier tongue, thus leading to the well-insulated glacier snout that they discuss. If the authors have a mechanism to prove that the material is eroded than they can continue using that term, otherwise it could be replaced with transport.

### Specific comments:

As for the writing of the manuscript, I think lines 1-16 on p. 3 can be written so that a testable hypothesis is proposed. The authors list approximate erosion rates from the Alps and from Norway, which could be higher due to the contribution of headwall erosion. The authors need to articulate what they are testing, instead of stating their goals. Perhaps they could add 'by quantifying erosion rates of lateral moraines from a

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DCG in Nepal, we will test the hypothesis that glaciers with disconnected tongues will have lower erosion rates than those with tongues connected to the headwalls". Lines 12-16 on page 3 do a good job of explaining the goals of the paper, but it is lacking a testable hypothesis.

Technical corrections:

Page 2, Line 31: The phrase "gullied upper part" is vague, I would suggest changing it to more descriptive language. I don't get a sense of what part of the moraines are gullied.

Page 2, Lines 34-35: The sentence: "The transport processes on the moraines are most active directly after deglaciation" makes intuitive sense but is a large claim. Does this imply that your modern study falls within the period of most active transport? I would either add another sentence or two linking this claim to your study, or remove it all together.

Page 4 line 10, that is a big assumption that no melting core exists in the moraine. Do they have any data that would substantiate this claim?

Page 6, Lines 12-15: This sentence reads as a hypothesis since the authors are predicting what the . It reads as more of a topic sentence and could be moved to the beginning of the paragraph.

Page 6, Lines 19-20: Here the terms "lower loose" and "upper firm" start getting usage as descriptors for parts of the moraine. I understand that terms loose and firm correlate to the different erosion rates, but perhaps more descriptive terms could be used, such as "low erosion area" and "higher erosion area".

Page 7, Lines 19-20: Solifluction is mentioned as a main transport mechanism, yet little discussion in the text is allocated to this process. Is there a way the authors can interpret solifluction processes from their DEM data?

Page 11, Line 13: Change mechanisms to mechanism

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Page 11, Line 22: Change are to is

Figures 4 and 5: It would be useful to have an index map of where these images/data are located on the glacier.

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