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Interactive comment on “**Spatial patterns in
glacier area and elevation changes from 1962 to
2006 in the monsoon-influenced eastern
Himalaya**” by A. Racoviteanu et al.

M. Pelto

mauri.pelto@nichols.edu

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Racoviteanu et al (2014) provide a useful inventory of glacier change from 1962-2006 in the region along the Nepal-Sikkim border. They further relate the observed changes to basic glacier characteristics further enhancing the paper’s value. The satellite image analysis approach is sound and well described. This comment focuses on just one key point glacial lakes with a few minor points.

Thank you for these useful comments. We have added a short discussion section in the new version of the manuscript to incorporate these suggestions (section 5.4, Glacier Lakes). See our answers below.

3963-22 and 3965-7: Glacial lakes at the terminus can affect terminus retreat. This should be an additional parameter to include. Must distinguish between supra-glacial lakes that have developed on the surface of a glacier, from pro-glacial lakes that are at the terminus. In spatial domain 2 a series of glaciers just north of Zemu Glacier: Changsang, East Langpo, Jongsang, Middle Lhonak, South Lhonak all terminate in glacial lakes, and some have had rapid retreat during recent decades. Some like Changsang Glacier have seen a recent merging of supra-glacial lakes into a single more appropriately termed pro-glacial terminus lake. Jongsang has a section of terminus that only has supra-glacial lakes. The impact of these lakes on retreat is worth including as a parameter. South and Middle Lhonak in particular have retreated rapidly with lake expansion. The lakes that have developed may have some relict ice cored moraine on their banks, but it is not plausible that the larger lakes indicated by red arrows in Figure 2 are underlain by glacier ice at this point (Figure 1 and 2).

We fully agree that glacier lakes constitute an important parameter, and should be included. For this paper, we have not included the lakes since we have not fully mapped the pro-glacial lakes. A recent study by Basnett et al. (2013) investigated at the effect of glacier lakes on glacier area changes, by separating glaciers with lakes and no lakes, debris cover etc. Including the lakes in the analysis is beyond the scope of this paper, but it would be a good parameter to include in the future, perhaps as a

parameter for a multiple regression analysis.

3966-9: Does refer to the South Lhonak as pro-glacial.

Change made.

Minor Points: 3959-6: The average slope is one useful parameter; however, most of the debris covered glaciers have very low slope ablation zones. Is the slope of the ablation zone a more useful parameter on these? If too difficult to address should at least be mentioned.

We agree with this point. We included the average slope in order to be able to compare with other studies. We have mentioned the impact of glacier-wide slope in the results and discussion. At this point it is too complex to do the analysis separately.

3690-24: There is no Section 4.3

The sections have been revised and re-numbered.

3963-11: Why is climate seen as the key instead of the heavier debris cover? What about comparison to the Bhutan record of Bajracharya et al (2013)? This likely supports your point.

We have revised this statement. Glacier elevation is actually the key parameter, and we have emphasized this in the new version of the manuscript. Also, we have added the comparison with the mentioned studies. Our results are indeed in agreement with these studies.

3964-22: Are not clean glaciers more sensitive to climate change because of a faster response time and hence more useful as a focus for purely climate change purposes?

We agree- however, we are not stating that we are assessing climate change.

3967-7: How valid is such a comparison from one day of temperature reconstructed data that is not from the principal melt season event?

We agree. We have removed the elevation difference section so this is no longer relevant here.

Figure 1: Map of glaciers with glacial lakes at their termini north of Zemu Glacier.

Figure 2: Landsat image from 2103 of glacial lakes north of Zemu Glacier:

C=Changsang, E=East Longpo, J=Jongsang, MS=South Lhonak, M=Middle Lhonak.

Bajracharya, S.R., Maharjan, S.B., and Shrestha, F.: The status and decadal change of glaciers in Bhutan from 1980's to 2010 based on the satellite data. *Annals Glaciology*. 55(66): 159-166. doi: 10.3189/2014AoG66A125, 2014.

Interactive comment on The Cryosphere Discuss., 8, 3949, 2014.

Fig. 1. Map of glaciers with glacial lakes at their termini north of Zemu Glacier.

Fig. 2. andsat image from 2013 of glacial lakes north of Zemu Glacier: C=Changsang, E=East Longpo, J=Jongsang, MS=South Lhonak, M=Middle Lhonak.

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Thank you for these references. We have labeled some of these glaciers in the revised figure, and have also revised the discussion.

Sincerely

Adina Racoviteanu