

Assessment of permafrost distribution maps in the Hindu Kush–Himalayan region using rock glaciers mapped in Google Earth.

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The paper presents an interesting assessment of two available global permafrost models using rock glaciers mapped in Google Earth as proxies. The manuscript is generally well written and of interest to the readers of The Cryosphere. However, the authors seem to ignore the importance of geology, topography and source of snow in the discussion of why rock glaciers are present in certain areas and absent in others. Even though the reviewer agrees that rock glaciers can be extremely helpful in determining the permafrost distribution in mountainous areas, their absence or the altitude distribution of the front may not directly reflect the lower elevation limit for permafrost to exist. Non-climate related parameters may also play a role in that distribution. As a reviewer I'm missing this critical discussion in the manuscript.

It is important that the authors are precise in their formulations. Permafrost is a thermal conditions and rock glaciers are indirect indicators for the presence of permafrost.

Below is a list of additional, more specific comments:

- p. 5295 - l. 3: Use a reference that supports the statement in the first sentence
- p. 5295 - l. 3: Permafrost isn't thawing, but degrading and aggrading. Only ground ice can thaw.
- p. 5295 - l. 4: What is meant by changes in societal conditions
- p. 5295 - l. 5: stick to either singular or plural in the example list
- p. 5295 - l. 8: what is a "permafrost phenomena"
- p. 5295 - l. 8: Gruber 2012 does not discuss societal impacts, but simply makes the same statement that is in your manuscript in the introduction. Please be careful how you make cross-references..
- p. 5296 - l. 7: use "extent" instead of "proportion"
- p. 5296 - l. 11: Do not use "cf." so often. Including a reference should be sufficient, no need to explicitly indicate "see".
- p. 5296 - l. 26: Use "such as ..." instead of "(e.g., ..."
- p. 5296 - l. 29: remote, high-elevation ...
- p. 5297 - l. 7: Add reference for the statement
- p. 5297 - l. 14: delete "cf"
- p. 5297 - l. 22: Add Capps, 2010 who coined the term.
- p. 5297 - l. 24: "... of buried **glacier** ice and **segregated** ice formed ..."
- p. 5298 - l. 9: delete "cf."

p. 5298 - l. 15: What about availability of debris / sediments? Topography is not the only limiting factor, but also geology

p. 5298 - l. 18: It is unclear why these results are conservative, can you provide a rationale for this.

p. 5299 – l. 2: it would be better if the authors use “indicator for the presence of permafrost” instead of “permafrost indicator”.

p. 5299 – l. 21ff: It is likely correct that the spatial accuracy of imagery available in Google Earth, in particular when also considering the historic images available, has not been the focus of research, the reviewer disagrees with the statement that Google Earth is not a commonly used tool. Several geoscientists in industry as well as academia rely heavily on Google Earth for various purposes.

p. 5300 – l. 13: Use italic, for example, to differentiate the R-function name from the rest of the text.

p. 5300 – l. 16ff: What scale was used for mapping? In order to compare the results of the mappers it is important that they work on the same scale, otherwise there would be a bias and a comparison cannot be made. Also, when mapping, did the mapper reduce the vertical exaggeration? And to what rate?

p. 5301 – l. 1: Please define “poor image quality”, what parameter was used to do this?

p. 5301 – l. 11: How was the activity of the rock glacier assessed? There is no rationale given for the criteria used. Considering that this is extremely subjective, it is recommended to not include the activity unless a proper criteria has been established that is supported by actual measurements which indicate current rock glacier movements. Unless relict, it also doesn't matter too much if a rock glacier is active or inactive.

p. 5301 – l. 13: “**d**escription”

p. 5301 – l. 15: “**Manually** mapped ...”

p. 5301 – l. 23ff: The degree of the two individuals is less important than their experience, ie. for how long have they been doing such mapping?

p. 5302 – l. 14: What “difficulties” were resolved during these meetings and doesn't such discussions affect the independency between the mappers?

p. 5303 – l. 7ff: It is unclear how the steepness of the front derived from the data uses could be used as an indicator for the rock glacier activity. Considering the raster point resolution of the DEM and the imagery, the error in the orthorectification of the images, the vertical and horizontal resolution and error of the DEM as well as the orthorectification of the DEM there are significant doubts how the slope at the rock glacier front could be accurately measured.

p. 5303– l. 10: In the HGH, vegetation is not a good indicator

p. 5303 – l. 14: How do you explain the difference in the rock glacier mapping. There seems to be a significant discrepancy in the level of details and attention made by the two individuals that did the mapping. It would be good if the paper discusses the guidelines and instructions that were given to the two mappers.

p. 5304 – l. 5: delete “e.g.”

p. 5304 – l. 10ff: Could that be caused by local climate conditions (microclimates)?

p. 5305 – l. 8ff: more details on basis of the two permafrost maps that were used and compared must be provided.

p. 5305 – l. 10: capitalize “Permafrost” when used in conjunction with a name, e.g. Sporadic Permafrost.

p. 5306 – l.7: specify what you mean by “relatively small difference” as this is a subjective description.

p. 5306 – l.15: You need to discuss the potential errors associated with the minimum elevations determined using Google Earth. The resolution of the DEM together with the uncertainties related to the mapping (also caused by the differences between the two mappers) impacts the elevation. Also, one has to keep in mind that the presence of rock glaciers is not only related to the permafrost, but also controlled by local geology and general topography. If the whole area is located at elevations with a high probability for permafrost to exist rock glaciers fronts will be high and cannot be compared with areas where the topography allows rock glaciers to be present in areas of low probability. In other words, minimum elevation is not the only factor and it is suggested that the authors include a discussion on topography and geology.

p. 5307 – l.6: “5 rock glaciers **mapped** ...”

p. 5307 – l.6: The fact that only 5 rock glaciers are outside the PZI is not necessarily an indicator for a good agreement. It could also be a sign that the PZI is too conservative.

p. 5307 – l.10ff: Here the impact of geology and general topography should be discussed. In general, the discussion should be extended and based on the experience the authors made in the HKH region the limitations of using rock glaciers for mapping the presence of permafrost should be discussed.

Figure 1: Coordinate system?

Figure 1: Lowest elevation <0m?

Figure 1: Source of the DEM?

Figure 2: Add north arrows. Scale is extremely difficult to read. Add locations for each picture (coordinates) in the figure caption

Figure 3: Add north arrow, scale, coordinate system

Figure 4: North arrows. scale is extremely difficult to read.

Figure 5: Add north arrow, scale, coordinate system

Figure 6: Do not use any bold font

Figure 6 and 7: y-axis: Use “Total rock glacier area per mapped ...”

Figure 8: Add north arrow, scale, coordinate system