

# IPA Action Group Rock glacier inventories and kinematics

Towards standard guidelines for inventorying rock glaciers

*(Responses to version 3.0)*



<https://www3.unifr.ch/qeo/geomorphology/en/research/ipa-action-group-rock-glacier> (Action Group website)

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## Box 0 – Preamble

Minor comments regarding form.

## Box 1 - Purpose of standardized guidelines

Minor comments regarding form.

## Box 2a – Motivations for inventorying rock glaciers

The bullet point title "Paleo-climate studies" could perhaps be changed in "Paleo-permafrost studies". The lower limit of rock glaciers is not only defined by MAAT but also by rock wall erosion rates. Relict rock glaciers, often reached larger sizes in shorter time periods than their active neighbors due to the extraordinary high erosion rates at the beginning of the early Holocene. Due to their fast growth they could reach elevations that were particular unsuitable for permafrost, already at the time of their formation. Examples are given in Kenner&Magnuson (2017) and Böhlert, Egli et al. (2011). I do not consider rock glaciers as good climate indicators and linking their front elevations to (past) atmospheric temperatures resulted in rather questionable results.

Thank you for this compilation work!! I have a small comment here: In this list of different motivations for inventorying rock glaciers, the term "functional rock glacier" is often used. However, the latter is never really defined. On the other hand, in the "activity" section, the term "active" is kept to define actually moving (or suspected to) rock glaciers and thus "functional" rock glaciers. I would therefore recommend to use only one term throughout the document to designate actually moving rock glaciers... Or to add a sentence somewhere to make the link between these two terms, either here in the motivation section, or directly in the activity section.

I strongly suggest to delete discontinuous permafrost completely. Please add a footnote indicating that the concept of continuous and discontinuous permafrost should not be used in mountain areas, but simply say mountain permafrost. We can then use altitudinal limits etc.

You need to define "functional rock glacier" I have never heard that term and would personally not use it.

I strongly suggest to not use the word "threaten". I recommend to use "being a risk for" instead. That is the language risk assessment experts are using when talking hazards affecting infrastructure.

"Page 5. First paragraph.

Again, this statement is ambiguous and needs rewriting. First, choose present tense (adding the perfect tense in brackets just serves to confuse the reader). Second, the sentence is highly ambiguous: it suggests that the inventory has been produced by the same "third user" who is later exploiting it. Here is my suggestion: the original motivation for producing a rock glacier inventory may contrastingly differ from its subsequent exploitation by a third user. Therefore, ..."

## Box 2b - Inventories achievement

add photogrammetry for DEM, not just LiDAR

change "...rock glaciers, whereas relict rock glaciers, for instance, are missed." to "... rock glaciers, whereas relict rock glaciers and potentially inactive rock glaciers, for instance, are missed."



Maybe change "inventories of moving and non-moving landforms" to "inventories of presumed/assumed/supposed moving and non-moving landforms"

Page 5. The acronyms DEM, LIDAR and SAR should be defined. If it becomes awkward to define them in the text, they could be spelled out in an acronyms list at the beginning or end of the document.

### Box 3a - Technical definition of rock glaciers

Page 6. First paragraph. Replace "can be various" by "may be distributed over several orders of magnitude".

change in ridge-and-furrow topo: "...associated with current or former compressive flow."

I don't quite understand the meaning of the last sentence of the second last paragraph under 3a. I think that a word may be missing and it should read as " ...nor of any other mountain permafrost-related ..."

Just one additionnal remark : Page 7, I wonder if we should not justify, even shortly, the reasons of the threshold we set up for the minimum size of rock glacier inventoried. The case of Ricardo Villalba's lawsuit, in Argentina, should make us cautious about that... A sentence like : "In coherence with global glacier inventories standards, and giving the technical limitations (that may evolve in the future), we recommend that the minimum rock glacier size applied for an inventory to be included into a global compilation should be 0.01 km<sup>2</sup>. Nevertheless, inventories at higher resolution are encouraged." Just a proposition, sorry if has already been discussed in the previous revision rounds (I didn't take time to verify)...

Related to debris covered glaciers I don't completely agree with the definition used. Some debris covered glaciers can have more than just the terminus being covered. In fact there are some debris covered glacier where 100% of the glacier is debris covered and I wouldn't yet classify them as a rock glacier because thermally and dynamically they are not behaving like rock glaciers. Their mass exchange may have started to alter, but the form is only in transition and some that have only recently been covered behave very much like a debris covered glacier.

"I assume that there has already been a lengthy discussion within the working group to come up with a consensus on the definition of a rock glacier versus a debris-covered glacier, so I am not sure how relevant my comment is. However, I am uncomfortable with this definition as it means that a glacier that has the ablation zone and a minor part of the accumulation zone covered with a thin debris cover would be considered a rock glacier. This could be a misleading label if the inventory is used for water resource evaluation, as such a glacier is likely to have a much higher concentration of ice and will be much more sensitive to temperature changes than a classic rock glacier with a thick layer of debris cover...I would therefore prefer the following definition:

Debris-covered glaciers are characterized by exposed ice due to the discontinuity of debris cover or thermokarst collapse, among other features, that create a rough surface. In contrast, almost no ice is visible on the surface of rock glaciers and they are comparably smooth and convex (Janke et al. 2015; Monnier and Kinnard 2017).



## Box 3b – Rock glacier morphological system and units

Page 6. Section b). First item. Replace "unit(s)" by "units". Grammatically, the plural in this sentence includes the singular as a special case. Therefore, the brackets are totally unnecessary and just confuse the readers.

Page 6. Section b). First item. Delete "for the latter". It confuses the sentence and is superfluous: a single unit is also spatially connected (by definition).

Page 6. Section b). First item. Replace "(in a toposequence or in coalescence)" by ", either in a toposequence or in coalescence". The brackets make this sentence confusing and are unnecessary.

Page 7. Second item. Replace "connection(s)" by "connections". In this sentence, the plural already includes the singular as a special case. Therefore, the brackets are totally unnecessary.

## Box 3c – Spatial connection of the rock glacier to the upslope unit

### **talus connected**

Maybe change "They should not be confused with protalus related to snow accumulation." to "They should not be confused with protalus-looking landforms related to (former or present) snow accumulation (i.e. pronival rampart)."

### **debris mantle connected**

add surficial: " ... by shallow, surficial mass movement ..."

### **landslide connected**

Question: Would that include cases where a glacier may have initially been present and covered by a landslide?

### **glacier connected**

There are either too many or too few hyphens in "debris-covered glacier-to-rock glacier". What you are trying to do is to build a compound adjective out of the expression "debris-covered glacier to rock glacier". To do that properly, you have two options. Either you connect ALL words (not only some of them!) by hyphens, as in debris-covered-glacier-to-rock-glacier, or you remove the extra hyphens and put all words within quotation marks: "debris-covered glacier to rock glacier".

### **glacier forefield connected**

Minor comments regarding form.

### **Comment on the 4 additional categories (Other, Poly-connected, Unidentified, Uncertain)**

None

### **General comment regarding upslope unit(s) connection**

Minor comments regarding form.



## Box 3d – Rock glacier activity

"Page 8. Penultimate paragraph ("Regional inventories ... developed"). This whole paragraph is badly written. It needs thorough revision. Sometimes the intention of the author is ambiguous, other times it is simply impossible to understand it.

For instance, the expression "operational procedures to the rock glacier surface motion from remote sensing technics [sic!] in particular" sounds gibberish. Besides, the correct word is "techniques", not "technics".

Also the use of the word "potentially" in the last line is confusing: either the developed categorizations are finer or not; they cannot be just "potentially finer". Of course, not all must be finer, but this sentence matters only to those that are indeed finer. "

Page 8. Penultimate paragraph ("Regional inventories ... developed.").

Replace "Regional inventories of rock glaciers have been historically achieved using" by "Historically, regional inventories of rock glaciers have been developed using".

Page 8. Penultimate paragraph.

I don't understand the sentence "Measurements (in-situ or remotely sensed) as well as valuable field visits have remained almost occasional."

What is the difference between "measurements in situ" and "field visits"?

Besides, why writing "in situ or remotely sensed" within brackets? I see no reason for that. It would be better to remove the brackets.

What is meant by "almost occasional"? "Occasional" is a state that cannot be partialized. It is like pregnancy or death: either it is, or it is not. Were the measurements and visits occasional or not? If one wanted to relativize, the most one might say is that it was "often occasional", but not "almost occasional".

"Page 9. Second paragraph.

This is another badly-written paragraph that needs thorough revision. Most of the information previously presented in this section was not about "scientific advances", but rather about "scientific observations and results". Besides, the expression "have suggested to explore the necessity" is awkward. Better is "have revealed the need".

Finally, I don't understand the last sentence. What does the "it" refers to? Isn't this sentence mostly a repetition of the previous?

"Page 9. Item "Transitional".

What does "non-dominant extent" mean? Please replace it with an understandable term. "

## Box 3e – Rock glacier destabilization

delete "discontinuous" see earlier comment about not using cont. and disc. permafrost in mountain regions.

I know that we had the discussion about hyperactive. I still can't think of a better term, but I suggest to add the following phrase at the end of the first paragraph:



""It is worth noting that in this context destabilization is not used to describe slope failure in a geotechnical sense, but solely used to describe this temporal rock glacier deformation irregularity.""

### Box 3f – Outlining rock glaciers

The restricted footprint does not differ that much from the extended footprint. Perhaps it would be more useful to have two distinct inventories? For example, the restricted footprint could exclude the frontal and lateral slopes and parts of the rooting zone that do not have topography to suggest the presence of ice.

"Page 10. Last paragraph.

This sentence ("It has been shown that ... of inherent water content.") is way toooooo long!!!! It must be revised and split into smaller and clearer sentences.

### Box 3g - Rock glaciers VS Debris-covered glaciers

Page 11. Replace "debris-covered glacier-to-rock glacier sequence" by "debris-covered-glacier-to-rock-glacier sequence". Alternatively, remove the extra hyphens and put the whole expression within quotation marks, as in: "debris-covered glacier to rock glacier" sequence.

### Box 4a - Detecting rock glaciers

Minor comments regarding form.

### Box 4b - Identification (ID attribution) and georeferencing

Minor comment or question: in the third paragraph of 4b, page 12, it was mentioned "[...] It should not refer to anything else than the three identifying aspects listed above." I am not fully convinced that it is clear what is meant with this phrase. Maybe it could become clearer by providing an example. However, such an example maybe could be more appropriately presented in the practical inventorying guidelines.

### Box 4c - Attribution of characteristics (attributes), including kinematical information

Minor comments regarding form.

### Box 4d - Outlining

General comment regarding the inventorying strategy: I strongly recommend that the source used for mapping (type, acquisition date), the date of the mapping as well as the operator responsible for mapping that particular rock glacier, including affiliation, is provided. This will allow to access the source material much easier, if needed. -> In the practical inventorying guidelines.

Minor question: In my opinion, the expression "Bounding rules [...]" is not appropriate - isn't it rather "Rules for drawing boundaries of the extended and restricted footprints [...], or something similar?"



Given that the geomorphological expression and motion of rock glaciers having a similar ice volume can vary significantly in different parts of the world, it would be very useful to include a section that describes the context for each region and specifically describes how the geomorphological expression and motion would differ between these regions for rock glaciers with similar ice content in the practical guide. A sentence or two could be added to highlight the most pressing motivation for studying rock glaciers in each region (e.g. water resources, rock glaciers as hazards in populated areas). -> In the practical inventorying guidelines.

## Survey - Destabilized vs Hyperactive

62,5% Destabilized.

37,5% Hyperactive.

1 participant vote for "Destabilized but also suggest "Unsteady" or "unstable".