

The Cryosphere Discuss., referee comment RC3  
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## Comment on tc-2021-167

Claudio Bravo (Referee)

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Referee comment on "Brief communication: A framework to classify glaciers for water resource evaluation and management in the Southern Andes" by Nicole Schaffer and Shelley MacDonell, The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-167-RC3>, 2021

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### **Review of "Brief communication: A framework to classify glaciers for water resource evaluation and management in the Southern Andes".**

Schaffer and MacDonell present a new classification of glaciers in terms of their hydrological importance. The new classification is proposed in the context of the ongoing discussion of the Glacier Protection Law (GPL) in Chile and how this classification could be useful in defining the level of protection. The classification is determined in terms of its sensitivity to environmental changes based on the percentage of debris-cover area and surface characteristics. Based on this, the authors mention that this classification could allow different degrees of protection depending on their sensitivity which, is closely related to the hydrological role. The classification includes debris-free glaciers (highly sensitive and greater contribution to streamflow), debris-cover glaciers, including thermokarst features and zones of exposed ice in the surface (semi-sensitive) and rock glaciers, classified as insulated from the environment and hence with a lower hydrological role. Some examples are given for the semiarid environment in Chile and Argentina. The manuscript is well written and could be an important contribution to the discussion of GPL but also to understand the hydrological role of glaciers and its differences.

My main concern, however, is related to the classification and the criteria used and how useful could be to GPL discussion. I understand this as a highly complex topic and probably there could be several classifications criteria depending on the researchers. So please, take my comments on this topic as recommendations. Having said this, I recommend clarifying some points in the manuscript in order to understand the proposed classification.

### **General comments**

## Classification

My general view is that the classification is simple and do not captures the diverse nature of glaciers in the Andes. In L115-116 it is mentioned that the guidelines need to be evaluated on a case-by-case basis. If this is the case, and I agree with previous reviewers, things seems to be more complicate following this classification. The hydrological role of a glacier, it is probably a concept that most of non-experts understand as a key role of the glaciers. In this sense, an explanation of the differences in time responses it is more adequate to introduce in a context of a GPL discussion in order to fully protect all glaciers. However, I agree that this classification can be useful to water resource management (L66-68).

## Concepts

The concept of hydrological role is not well defined in the manuscript. Following the explanation in L144-157, it seems that it is related mainly to the contribution of each type of glacier to streamflow at an annual scale. I suggest a clearer definition of what the authors mean by "hydrological role" including temporal and spatial scales and also the potential contribution to groundwater. The authors mentioned (L30-33 and L155-157) that insulated glaciers (rock glaciers) storage and delay the runoff. This is an important point as the hydrological role and importance of these glaciers have a different time scale in comparison to debris-free glaciers and must be included to define the hydrological role.

"Sensitivity to environmental changes" I understand that probably the use of "environmental changes" is used to include the atmospheric drivers of the melt as well as the feedback (positive or negative) that the debris-cover and glaciers surface characteristics exert on melt rates. However, the concept of "environmental changes" is wide and includes several other factors. I suggest clarifying what exactly means "sensitivity to environmental changes". Maybe, constrain this concept will allow a clearer link between the classification and the hydrological role. I think in a concept like "sensitivity to melt drivers" or probably something better.

## Clarification on the level of protection

In order to avoid confusion, I suggest including, explicit, the order of the level of protection for each type of the classification i.e. the type that needs more protection according to your classification.

## **Specific comments:**

L20 "Sendado" to "Senado" (also in the reference list).

L274-278: Although is not the focus of the paper, I think that the other values of glaciers mentioned here must be included in the Introduction. This manuscript is concentrated on the meltwater contribution to runoff, which of course is important, but as mentioned, glaciers also play other key roles.