

## General comments:

The work provides an interesting historical progression through how hazards and risks are dealt with within Alpine regions and, therefore, falls well within the scope of the journal. I recommend this paper for acceptance, given the suggested revisions. The previous referee has already provided an extensive span of revisions with regard to the scientific literature that should be included, with which I fully concur. However, I would encourage the authors to look at the following reference, especially for section 1.1. Characteristics of mountain risks:

Gardner, J.S. 2015, 'Risk Complexity and Governance in Mountain Environments' in *Risk governance. The articulation of hazard, politics and ecology*, ed Urbano Fra. Paleo, Springer, Dordrecht, pp. 349-371.

One important, general comment for the paper is that there is not a clear differentiation between what is meant with “general risk governance frameworks” and “mountain risk governance”. There is also no clear definition of what is meant with the term “mountain risk governance” itself. With regard to risk governance, the standard IRGC term is provided and is useful. However, it is not descriptive enough for the purposes of the article (i.e. the working definition, though not clearly stated, appears to be more specific with respect to the stated principles of inclusion and context specification).

A clear explanation of these terms is necessary especially in consideration of the main conclusions of the work. Simply put, if you do not define a concept or framework well (especially in the beginning of the work) and then claim that this concept or framework will fail or is not applicable, it can be very difficult for the reader to believe this claim.

## Specific Comments:

### Abstract

Page 430, line 5: I would encourage you to please use a different word instead of the word “indicators” in line 5. Indicators are for the purpose of measurement. The items you are listing do not provide a form of measurement (neither quantitative nor qualitative measurement).

General: Please also clearly communicate in the abstract that these paradigms are something you have developed. As it is currently written, the reader might assume you are missing some references (as I had upon my initial reading of this article).

Page 430, line 9: When you state “...this transformation” in line 9, it is also unclear to what you are referring. Are you referring to the history of all paradigms, the transformation from the third to the fourth paradigm?

General: From what data did you conduct the historical analysis? Is this primarily a review of literature on the topic? Did you use any archives? There is some idea of what exactly was collected when the country-specific examples are given; however, this is rather vague and for purposes of enhancing scientific replicability it would be important to state the types of evidence used.

It would also be helpful to use a more concrete example of what is meant by “[n]ecessary adaptation...” in the last sentence.

## 1. Introduction

General for the Introduction: Similarly to the abstract, it should be clear from where these paradigms originate (e.g. that this is an innovative product of the authors and from what data these were derived). The clear provision of steps and scope is well done and much appreciated.

Page 431, lines 8-10: I would argue that the context of mountain risks in the Alps is not heterogeneous and may better be described as in the plural as contexts. In this same sentence, what is meant by risk governance concepts is not clear. This clarity could be greatly improved if the specific concepts are mentioned (e.g. are the authors referring specifically to risk communication and participation in particular?).

Page 431, line 15: A citation is needed especially for the term societal values. In the next sentence, line 16-18, what is meant with common frameworks? (e.g. are these formal and informal regulatory frameworks?)

Page 431, lines 21-25: The previous referee also made a comment on this part of the text with regard to "...intensified or mitigated in the short term..." Are these two words meant to represent a dichotomy related to how human activities can affect natural hazard processes?

Page 431, lines 25-27: The issue of "spatial scale" mentioned here needs some adjustment as does the sentence "Mountain risks are local..." I would add "...that are in part sensitive to global (climate) as well as local parameters (local topography and settlement patterns)..." (I would also refer to the chapter from Gardner (2015) here). The next part of the sentence concerning "...discrepancies in spatial scales..." could arguably be changed to discrepancies between different localities that affect the uncertainty but also the complexity of risk. An example could also be given, e.g. when one municipality or village is typically affected differently from another, but the regional administration in which both reside must find a solution (a regulatory framework for example) that can be universally applicable.

Page 431, line 27: It would be helpful to have a definition and reference for uncertainty. A citation is also needed for the sentence starting with "Acting under conditions..."

Page 432, lines 4-9: It is unclear in these sentences whether or not Hufschmidt et al. (2005) is still the source for the information presented here.

## **2. Historical perspectives and outlooks**

Page 433, lines 16-17: The second sentence here is a very broad sweeping statement. Citation needed.

Page 433: The temporal boundaries (specifically the starting point) of the historical analysis is not very clear. "...every historical period..." is mentioned and then examples are given including "...the Enlightenment..." and "...The Lisbon earthquake of 1799..." The starting point of the analysis should be clearly stated, early on in the work and at the very least within the beginning of section 2.

Page 434, lines 2-4: All of Europe's rivers? It would be helpful to again indicate a citation for this statement. If this is Duile (1826), this should be clearly indicated.

Page 434, line 15: It is unclear to what "This early assessment..." is referring to. Is this Covello and Mumpower (1985)?

Page 434, last sentence: Regional risk cultures are stated as requiring close attention in the future. They, arguably, require close attention now. There is a fair amount of literature related to the topic of risk culture (and culture of risk) (see the works of Thompson, Douglas, Wildavsky, Rayner (Risk Culture); also Othengrafen, Kneiling, Sanyal, Young (more related to Planning Culture within European regions)). The authors may be interested also in considering Price and Thompson (1997) "The complex life: human land

uses in mountain ecosystems”. Another recommendation is to consider Mercer et al. (2012) “Culture and disaster risk reduction: Lessons and opportunities”. These recommendations can also be considered for future reference. However, I would argue that (due to the importance of this topic) it is essential for the authors to clearly communicate that, though important, risk culture is not considered as a central foci of the research presented.

### **3. Paradigm based model for the dealing with mountain risks**

General: No dates for the boundaries of the paradigms, nor for the historical analysis itself, are given until this section. Some indication of these boundaries should be given earlier in the paper.

Figure 1: Again, no dates (even if approximate) are provided but would be very helpful.

Page 435, lines 14-17: Are the six key characteristics something you have discovered? How was this determined? Thematic analysis of patterns or macro topics revealed during historical analysis?

General: A better explanation of complexity is needed. The same goes for uncertainty. These are not well differentiated, nor are they well explained in the present state of the paper.

Page 436, lines 7-9: The authors state that the conceptual model “...does not acknowledge the vast natural, cultural, legal and institutional diversity in mountain regions...” However, I would argue that the work presented by the authors perhaps does (and should) acknowledge the existence and importance of these components, but that an elaboration of these does not fall within the scope of the model. It would almost seem contradictory to say that there is a transition toward a risk governance paradigm (which emphasizes context specificity) but to also say that there is no acknowledgement of this context specificity.

General: I agree with the previous referee that the examples provided from the different Alpine countries are unequal in elaboration and depth of discussion. It would be clearer, especially in terms of your available evidence base, to provide information for all examples consistently with respect to each paradigm. If no evidence exists for each of the examples, e.g. for France or Italy for the hazard protection paradigm, then this should be clearly stated.

General: A visual presentation of the evidence provided would be tremendously helpful. This could, for example, be in the form of a timeline. Some ideas: provide the evidence (milestones or events) along the timeline with a label or identification for which country it is applicable. It may also be helpful, especially to highlight that which corresponds to developments in risk communication and participation, as these are key foci of the research presented. This could be done by paradigm or in general.

Page 439, line 4: It would be helpful to indicate in the beginning of the paragraph whether or not the discussion has turned back to a general discussion and not a given case.

Page 439, line 15-17: Please at least paraphrase the quote or find a replacement. Almost the exact same quote is previously provided on page 437.

Page 439, lines 20-22: I would argue that values at risk should rather be changed to elements at risk. The sentence starting from line 20-22 also needs some citation.

Page 439, line 24: What exactly is meant with risk cycles? Is there a citation for this term? Does this rather refer to disaster risk management cycles, or a part of DRM cycles? A citation is needed here and should be used in line 26 along with a better explanation and definition of what is meant with risk cycles.

Page 440, lines 1-5: This text contains some pretty broad sweeping statements which would be much improved by supporting references. The way in which these statements are written seems to imply that mountain risks exclude any form of technical risks. These are, arguably, not completely separate terms. I would also argue that replacing the word “hazard” with the word “risk” in the beginning of line 5 would be more fitting for the context of the discussion.

Page 440, lines 6-10: Citations are needed for these terms.

Page 440, line 18-20: Deficit model seems to be a very specific term that may merit further explanation.

Page 441, line 10-12: Citation needed for this statement.

Page 441, lines 17-22: Has the second stage of participation been achieved through these projects, through legal or regulatory developments, something else? It is not so clear what has enabled this achievement.

Page 443, lines 1-4: Citations needed.

Page 444, line 15-16: Citations needed.

#### **4. Conclusions for mountain risk governance**

Page 445, line 11: What is meant by “consistent approaches”? Does this imply universally accepted and applied use of risk governance principles? Additionally, are the risk governance principles (in line 12) referring only to context specificity and inclusion? This is not clear.

Page 446, lines 1-2: Which risk management cycle is being used? Is this the standard DRM cycle? The way in which the sentence here is written, the terms “...risk assessment, risk evaluation and the development of mitigation measures” seem to be unclearly associated with the cycle. Are they part of the cycle, pervasive throughout all phases (e.g. of prevention, response, and recovery?).

Page 446, line 4: Where does this triad come from? Is this something that is explicitly stated in a particular reference, is this something revealed and used as part of the description for this paradigm?

General: It is also not clear to what extent these paradigms might be applicable outside of Alpine regions. This is not necessarily within the immediate scope of the work but would be helpful in identifying applicability to other regions, as arguably a move toward greater inclusion and context specificity is not limited to Alpine regions.

Page 446, lines 11-14: These statements need more support.

Page 446, lines 15-18: Also a very general statement with very limited support.

Page 446, line 20: This statement could be strengthened by providing a more concrete example of what is meant with “profound adaptations and innovations”.

Page 446, lines 26 (and in general): It should be clear when the term risk management is being used and when the risk management paradigm is being used. There are many different definitions of the term risk management. Some of which include risk assessment and others which do not. In this case (line 26) it would also be helpful to be clear that the paradigm is being referred to.

Page 446, lines 27-29: I would disagree with the statement that “Legislation acknowledges only constitutionalised forms of participation.” The word constitutionalised may be the key issue here. This implies quite literally that legal mechanisms created for participation are only found via mandate of a given constitutional framework. The next statement is also in need of some reflection. There are some legal instruments in existence for participation in mountain regions, (and in the Alpine regions specifically). Empirical work from the FP7 project CHANGES also reveals that, when looking at planning processes and processes for environmental impact assessment also in relation to the management of risks, legal mandates for public inquiry periods provide at least a “consultative” level of participation for countries like France and Italy. The statement made here, I would argue, is still valid if the authors are referring to co-decision making. However, there is also work from Bruna De Marchi and Anna Scolobig conducted in the FVG Region in Italy that would provide evidence to the contrary (e.g. that there is some progress toward co-decision making after the last major event in 2003).

Page 447, lines 17-20: It is not clear here what is meant with rules, processes, and instruments of mountain risk governance. This needs to be clarified. The statement provide here would benefit from further elaboration.

In general: It is not clearly stated what existing mechanisms there are for participation and inclusiveness. This would be very helpful in adding validity to the claims made in the conclusion.

## Technical corrections:

### Abstract

Page 430, line 2: The very first sentence is missing a word. “The complexity the management of mountain risks...” You need an “in” or an “of” after “complexity”.

Page 430, line 4: A comma is needed after “...mountain risks...” in line 4.

Page 430, lines 11-13: The order of the second to last sentence should be rewritten in reverse order. (E.g. change to: “The suitability and applicability of general risk governance frameworks in the context of mountain risks are discussed based on a historical analysis.”)

### 1. Introduction

Page 431, line 6: The sentence “...outlooks on approaches to mountain risks are represent the basis of a...” needs some revision. Recommended, “...outlooks on approaches to mountain risks are **represented as** the basis of a...” or “...outlooks on approaches to mountain risks represent the basis of a...” (“are” removed).

Page 431, line 9: suggested revision “...risk governance concepts **with respect** to the...”

Page 432, line 8: I suggest a wording revision for this sentence as follows “...characterize **how mountain risks are dealt with** across the Alpine region, as **will** be described below.”

### 2. Historical perspectives and outlooks

Page 434, lines 2-4: Need for sentence inversion here. Recommended revision: “Collective interventions against flooding along Europe’s rivers represent an early stage of institutionalized risk reduction at the beginning of the 19<sup>th</sup> century.”

Page 434, line13: Recommended revision: "...in **the** future Covello and Mumpower (1985)..."

### **3. Paradigm based model for the dealing with mountain risks**

Title of section: improper wording. Please change, "Paradigm based model for dealing with mountain risks" (remove "the").

Page 435, line 1: Same as above comment.

Page 441, line 1: Some sentence revision needed. Suggested revision: "...vulnerability assessments are deepened **and** have been elaborated and partially..."

Page 443, line 6: Sentence revision. Suggested revision: "...risk management **is** at a mature stage."

### **4. Conclusions for mountain risk governance**

Page 445, lines 23-27: Sentence revision. Recommendation: "...have been raised from three sides; **the** public in affected regions, science, and international policy-makers. Stakeholder integration in the...all phases of the risk management cycle; from prevention..."

Page 447, lines 13-14: Sentence revision. Recommendation: "...may **therefore** provide..."