NHESS April 2021, 2nd review

REFEREE #1 RESPONSE

In this review of the article, we have taken into account all of the recommendations given and made the following changes:

The paragraph 3.2 “Implementation of the method” describes how the method was applied to the case study, and contains the workflow of figure 5 which, upon careful reading, shows as part of the presented procedure a cluster analysis, which is explained in the following paragraph of discussion. Indeed, much of the discussion section lists the results of the cluster analysis leading to two negative consequences:

1) the cluster analysis is weakly explained, important details are not provided, even if listed in Tables 7 and 8, they are not sufficiently described in the text,

We have included more extensive explanations that are more pertinent to the cluster analysis carried out, giving reasons for the number of groups used. We also give details of the procedure for regrouping into four different levels for the values of the centroids calculated by the cluster analysis. All of this is summed up in the new Table 7 entitled “Centroid classification values”.

2) the discussion paragraph suffers from lack of arguments. In particular, I can't understand how the cluster codes listed in table 7 are transformed into three classes of risk building management (improvable, reviewable, suitable). I suggest a revision of the two paragraphs.

Indeed, the procedure for assigning the types of management shown is better displayed now in the new Table 7. The definition for these types of management is based on the slope in degrees of the straight line calculated for the upper (or most recent) section in the graph of annual evolution in RR (mRRHi variable); in other words, the one corresponding to years before the 1980s. It was not well executed in the article’s original table so we have modified it, correcting some values.

We recommend reading Table 7 again to better understand the solutions provided to the suggestions proposed.

The other two errors noted in the text have also been corrected.

REFEREE #3 RESPONSE

In this review of the article, we have taken into account all of the recommendations given and made the following changes accordingly:

1) The introduction section underline the role played by a suitable risk management and in particular of a suitable risk building management. However, this part of the story is a bit neglected in the interpretation of the results. I strongly suggest to specify better the focus of the analysis since the introduction and to enforce the results' discussion part accordingly.

The following paragraph has been introduced at the end of section 1:

Another significant aim of this work should also be noted: This involves differentiating correct management of the terrain (specifically addressing its occupation by residential housing) from management that can clearly be improved. In particular, considering the risk of landslide for residential housing, the possibility of said risk becoming stabilised is studied over the time series. In this case, the management can be deemed adequate.

Nevertheless, if the risk increases over time, then it can be attributed to improper management, which should be corrected. The aims of this work also include analysing this situation, as well as determining what causes an increase in landslide risk, for example by considering geomorphological dynamics, inadequate land management, even bad luck, etc.

2) On the same line of point 1, it would be interesting to underline that the story descripted on Figure 1 is only one of the potential scenarios. In fact, would be interesting to present another figure where another urban sprawl model is presented (e.g. it is possible to argue that more safer places are occupied at the very beginning of the urban growth process while during the urban sprawl less convenient places in terms of landslide risk, or general risk, are used). This would give the chance to introduce the pivotal role of landslide risk management in the growth of these territories.

Indeed, the pattern of growth in risk considered to be non-suitable or improvable would be a good contribution. This new theoretical growth pattern has thus been included in Figure 1, accompanied by the following text below the figure.

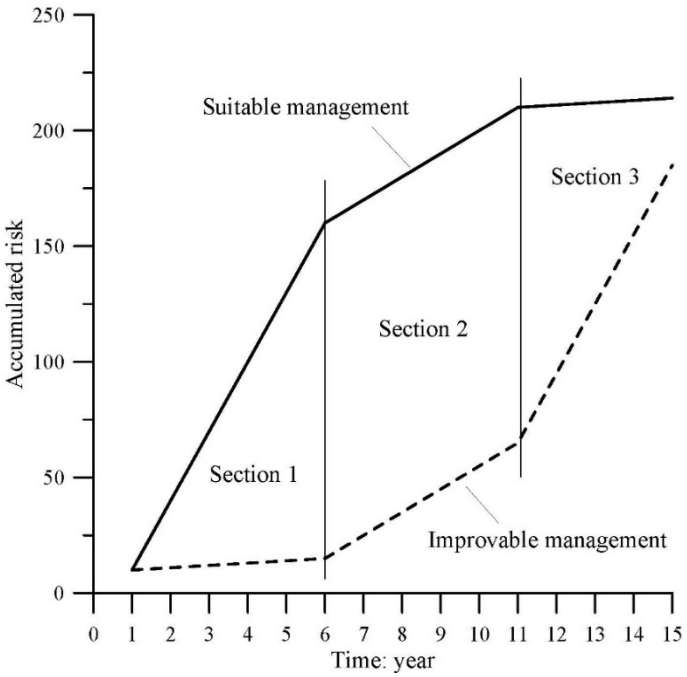

Figure 1. Theoretical evolution of risk accumulated over time for a one-year series pattern

However, a varying panorama of unsuitable or improvable risk can also be found (Fig. 1). This type of growth in risk can arise when the pressure to build residential housing is so great that spaces become occupied that do not have the optimal conditions in terms of location and which until then had maintained their natural characteristics. Building on such spaces may entail taking greater risks because safer terrains have already been used up. Hence, the great increase in risk in Section 3 (Fig. 1, "Improvable management" line), should not be admissible in proper territorial management, and it is thus essential to provide tools to demonstrate such anomalies as shown in this work.

3) I have some concerns on the cluster analysis. In particular, there is a lack of details. As an example, why the choice of 14 clusters? Finally, the organization in the four groups A, B, C, D is not clear too. On the same line, please provide more details on the sample selection and in the application of the cluster analysis.

It is true that establishing the number of clusters is not simple, nor are there standard procedures to solve this, but it is often solved by simply applying common sense. In this case, we have used a minimum of 10 clusters as the basis in order to adequately include the high and low interval of variation of the three variables considered in the analysis. It should also be mentioned that we are certain there are two cases that must belong to different clusters. These are the two municipalities with the greatest rate of construction, which clearly have different behaviours in their annual variation in risk: Benidorm with mRRHi= +38°, and Calpe with mRR Hi = -38°. Based on 10 clusters, trial and error calculations have been carried out upwards. The two are separated when 14 clusters are reached and we understand that this number is suitable because it is accompanied by a definition that is congruent with the rest of the groups.

The clusters have been organised by grouping them by greater or lesser value of their centroids into a series of levels. Four levels have been established: A (very high), B (high), C (low) and D (very low), which are obtained by applying the percentiles of 90, 60, 30 and 0% of the series of one-dimensional centroids. These limits thus established are particularly intended to restrict the upper values of the series (percentile > 60% in A and B). It is thus possible to more clearly highlight the cases that should be addressed in order to manage risks properly. Four types of risk management evaluation have been defined, taking into account the mRRHigh value (final section of the slope of the straight trend line).

The following table specifies these intervals and is now included in the text as Table 7 ("Centroid classification values"):

					Risk Management	
Percentile	**Level**	**Code**	**SpGFA × 1000**	**RRt**	**mRR High**	**Type**
100 - 90%	Very High	A	170.7 – 131.0	821 - 626	86 - 80	V. improvable
90 - 60 %	High	B	131.7 – 20.8	626 - 163	80 - 48	Improvable
60 - 30%	Low	C	20.8 - 4.5	163 - 88	+48 ~ -40	Reviewable
30 - 0%	Very Low	D	4.5 - 0.9	88 - 0	-40 ~ -72	Suitable

Lastly, greater explanations and details have been added to the text regarding the results of the cluster analysis and how they were obtained.

4) The other major point is related to the description of the results. In the present version, this part is hard to digest. In order to improve the readability of the section it would be interesting to present results in Figure 6 aggregated also for municipalities with suitable risk building management with respect to the non-suitable municipalities

We agree that the interpretation of the results has been particularly complicated on dealing with real cases calculated for 50 municipalities with very different growth patterns in RR. Figure 6 shows two municipalities with a high construction rate near the coast but with very different behaviour as regards the growth of risk in residential buildings (Altea with mRRHi= +85° and Calpe with mRRHi = -38°). We understand that these are significant extreme examples and that they should be shown apart due to their unique nature. We consider that completing these graphs with aggregated examples will not provide greater information and may hinder their individual interpretation, so we have preferred to maintain the original arrangement.

However, in the results section we have introduced new references to Fig. 1 in order to better explain the curves shown in the aforementioned Fig. 6. These references are intended to improve comprehension of this section, since they deal with general patterns recognisable in the municipalities mentioned.

Explanations in the section devoted to discussion of the results have also been modified and simplified to improve comprehension, deleting complex references and making them more readable. The text has been adapted to the changes made in the previous section. Fig. 8a has been suitably adjusted.