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Interactive Comment

Interactive comment on "Sea cliff instability susceptibility at regional scale: a statistically based assessment in southern Algarve, Portugal" *by* F. M. S. F. Marques et al.

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The authors wish to thank the careful revision of the manuscript and the valuable suggestions. Most of the corrections and suggestions will be included in the paper to submit for publication in NHESS. The referee comments (Q) are followed by the authors answers (A).

Q: In Section 3.1, I do not see the need for presenting the two methods used (Information Value and Logistic Regression is such detail. These are, and particularly LR, very consolidated methods well known in the literature.

A: In the specific context of landslide hazard assessment these methods are well known. The detail on the methods was included mainly because researchers working in coastal areas are not aware of the use of these techniques.

Q: The authors show the non-cumulative statistics of the cliff retreats using a simple histogram (Fig. 3). There is a problem with the histogram and its significance due mainly to the selection of the classes, of irregular size.

A: The class limits were chosen according a 1.5x relationship, because a linear equal interval scale will be not appropriate to characterize the cliff retreat data: Small divisions would produce a large number of larger retreat values classes without any occurrence and large interval classes would be not discriminant in the smaller cliff retreat values. In the graphs, departing from a lower limit of 1.055, which also corresponds to the lower limit of detectable cliff failures with the methods used in the study, each class limit was obtained multiplying successively by 1.5, resulting class limits with nearly equal size in a logarithmic scale. The lower limit (1.055) was adjusted to produce the larger retreat values class with limits close to the actual cliff failures. The first two classes were also grouped. This approach follows the same principles as, for example, ISRM suggested spacing of discontinuities (6cm, 20cm, 60cm, 200cm, 600cm, i.e. a ratio of approximately 3)). A new histogram was prepared with all failures, Cretaceous rocks failures and Miocene+Pleistocene failures, but without grouping of the first two classes. In addition a cumulative plot was prepared including the same 3 series of data, to enable a more detailed observation of the recorded cliff retreat values.

Q: I reckoned that the authors determine and show the non-cumulative frequency-density (or probability-density) of the cliff retreats. My understanding is that this figure will represent better the statistics of the coastal retreats. Two (or three) curves can be prepared, for the events in Miocene & Plio-Plaistoce sediments, for the events in the Cretaceous sediments, and for all the events. To determine the frequency (or probability) statistics the authors can use different methods and tools, including e.g. the tool proposed by Brunetti and others, Probability distributions of landslide volumes.

Nonlineal Processes in Geophysics, 16, 179-188, 2009.

A: The purpose of the graph was to show the characteristics of the inventory and not its statistical properties. The latter approach that relies on a kernel binning of size data, although much more appropriate in statistical terms of the magnitude-frequency relations, would tend to obscure the raw data, and these statistical relations were not the object of this study. For these reasons this approach is not considered.

Q: I am not really convinced that the Information Value Method ads anything significant to the results, or the discussion. This is not surprising, giving the simplicity of the model, compared to a Logistic Regression model. Although not shown, I presume that a susceptibility zonation prepared using the IVM is similar to the susceptibility zonation prepared using LR, and shown in Fig. 8. The authors should consider deleting the parts of the text, and the analysis dove with the IVM.

A: Researchers dedicated to coastal areas are not familiar with these statistical methods. IVM is included because it is simple, easy to understand and enables also a detailed observation of the scores of each variable and of the importance of each factor. For these reasons the authors believe that this method may be useful for preliminary applications in other coastal areas.

Q: Section 6, Conclusion does not really read as a Conclusion chapter. The main relevant findings and lessons learnt are not clearly identified in this important section of the paper. Consider rewriting the text, entirely.

A: Suggestion considered

Q: Specific comments: Page 1967, lines 6: What does it mean "consolidated urban areas"?

A: Urban areas with dense occupation with buildings - corrected

Q: Page 1967, lines 11: "(retreat rates)". Redundant. Consider cancelling it.

A: Corrected

Q: Page 1968, lines 5-10: Consider also the recent work by Katz, O., and A. Mushkin (2013), Characteristics of sea-cliff erosion induced by a strong winter storm in the eastern Mediterranean, Quaternary Research, 80(1), 20–32, doi:10.1016/j.yqres.2013.04.004,

A: The paper, was only available online (24 May 2013) after the submission of the paper in revision (17 May 2013). The paper presents interesting data on the cliffs response to a storm but there is no attempt to perform any hazard assessment. Reference is included in the next comment place.

Q: Page 1968, lines 20-125: Consider the recent work of Dewez, T. J. B., J. Rohmer, V. Regard, and C. Cnudde (2013), Probabilistic coastal cliff collapse hazard from repeated terrestrial laser surveys: case study from Mesnil Val (Normandy, northern France), Journal of Coastal Research, (65), 702–707, doi:10.2112/SI65-119.1.

A: Reference included

Q : P. 1969, L. 13-14. “low height”. Please be more specific?

A: 6m high - corrected

Q: P. 1969, L. 21-28. Language in this paragraph is difficult to follow. Please rewrite.

A: Corrected

Q: P. 1970, L. 19. Between 1947 and 2007 there are 61 years, and not 60 years. Please check the exact length of the period. This has consequences on the computation of the rates.

A: The 2007 photographs were made during late Spring and Summer 2007. Although there are no indications on the precise dates of the 1947 photographs, these type of surveys are usually carried out during the part of the year with better meteorological conditions (late Spring, Summer and beginning of Autumn), with photointerpretation confirming this comment. It is assumed, as a best estimate, that the surveys were made in the middle of the indicated years (1947 and 2007), covering a period of approximately 60 years.

Q: P. 1970, L. 20. Here, and in other parts of the text, do not use “photo(s)” but “photograph(s)”. Q: P. 1970, L. 27. And ROC curves? Q: P. 1971, L. 16. The text “The geological structure is mainly tabular, horizontal or gently dipping to E or SE” is unclear, or the text redundant. Please clarify. Q: P. 1972, L. 1-8. Text in this paragraph needs to be clarified. What is a “general slope of 60–90”? Explain “karst sinkhole exhumation”.

A: Corrected

Q: P. 1972, L. 19. “geological and gemorphological aspects”. I am not sure I agree. Major lithological units; geological structure (bedding dip in relation with the cliff faces; presence of faults) are geological factors. The presence and type of cliff toe protection can be geomorphological but also antropogenic, depending on the kind of protection. Please be more specific. Here, and were you explain the different variables used for the analysis.

A: Cliffs which were object of heavy engineering works (sea walls, concrete revetments) were not considered in this study, mainly because their evolution is no longer controlled by marine erosion. The protection features included in this study are only the result of natural processes.

Q: P. 1975, L. 25-26. Doesn’t this depend on the scale of the available photographs? It would be useful to have a table listing the main characteristics of the aerial photographs used.

A: The smaller size of the cliff top retreat which is detectable on aerial photographs based studies depends naturally on the scale of the photographs used. The values indicated are for the conditions of this study. A table with the main characteristics of the aerial photographs used is included.

Q: P. 1976, L. 14. What is a “sea stack”?

A: Redundancy corrected

Q: P. 1976, L. 19. “Horizontal area”? Is this the planimetric area? Clarify.

A: It is the planimetric area of the cliff failures, corresponding to the area defined by a vertical projection on to a horizontal plane of the lines corresponding to the cliff top line after and before the occurrence of a given cliff failure. Term corrected.

Q: P. 1976, L. 25. 61 years. Please check.

A: Checked. The monitoring period is 60 years.

Q: P. 1977, L. 21. “local long term water pipe rupture”. Is this antropogenic, then? For how long? Is this common?

A: Most likely caused by the water supply pipe rupture which remained undetected for several weeks. This is not common: the number and extent of buildings and water supply pipes located near the cliffs are quite limited. Text clarified.

Q: P. 1978, L. 5. “for this type of studies”. What type of study? Please be specific.

A: Landslide or cliff failure hazard studies.

Q: P. 1979, L. 16. “by order of dominance in each class”. Please clarify.

A: by order of dominance of the lithological types in each class. Text clarified.

Q: P. 1979, L. 15 to P. 1980, L. 8. This is rather boring to read. The authors should consider reducing this part considerably, and adding a new Table with the same information.

A: Suggestion accepted. List of variables in table 1.

Q: P. 1980, L. 12. “Systematic checking”. Can you be more specific?

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A: Very detailed checking of erroneous contour line elevation values, which was performed over all the area covered by the maps.

Q: P. 1980, L. 19-25. Consider a different analysis. Use only the areas not affected by the landslides, and check if the statistics are similar, or not.

A: We do not agree with this approach: the larger failures occupy large parts of the terrain units where they occurred and in many cases, the only part of the terrain units not affected is the toe. In these cases the slope (maximum and mean) would be a much worse representation of the cliff slope, both before and after the failures.

Q: Table 1. This is a rather long table. Is it really useful? The author should consider putting it as an "Ancillary material".

A: The table is considered necessary. It shows all the factors studied for the models building and their classification in variables, which description was reduced according to a previous comment. It enables also a close view of conditioning factors and variables characteristics and scores.

Q: Figure 1. This Figure needs to be improved, significantly. Geographical coordinates for the main map are needed. The legend is inconsistent. Either you show ages of the rock, or the type of the rocks. In the graphical legend one can use symbols, and then explain the symbols in the caption. Dashed lines are uncertain, buried (?) faults? The caption of the figure is incomplete, and the text unclear. It is not really clear here (and also in the text) how the sectors were "defined according space frequency of cliff failures and corresponding horizontal area lost at the cliff top." This should be clarified.

A: Corrected

Q: Figure 2. Font sizes for axis labels and explanations are too small. x-axis is in bold, y-axis is not. Delete reticule, add specific reference to the sectors defined and shown in Fig. 1. You can use different colours for the symbols, depending on sector. Use of colour is free in this journal. Use of the cumulative distribution does not add much to the figure. Consider using a simple histogram, or better to show the histogram and the cumulative distribution.

A: The authors are convinced that the cumulative plot is the best representation of the data. Due to the very irregular spacing of the cliff failures, a histogram is not adequate: small distance divisions (x axis) imply a large number of 0 event classes, and large distance divisions will implicate data amalgamation.

Q: Figure 3. Font sizes for axis labels and explanations are too small. x-axis is in bold, y-axis is not. Delete reticule. Why using such odd classes for the bins, like 2.4, or 3.6? Explain if lower/upper limits of the class is contained or not in the class. You can use different colours for the different lithologies shown, with reference to Fig. 1, if possible.

A: Corrected. Explanation of bins given in 2nd question.

Q: Figure 4. Why using such odd classes for the bins, like 2.4, or 3.6? Explain, or use round numbers. Explain if lower/upper limits of the class is contained or not in the class. Use colours for the symbols, preferably the same colours used in Fig. 4. Why do you show the dashed line? It does not show a physical limit, really. You can have retreats larger than H, for a failure that involves a cliff of height = H.

A: The figure uses no bins, it's a xy plot (probably "copy past" fault). Dashed line corresponds only to a limit of 1/1 (Cliff height/maximum retreat). Explanation included.

Q: Figure 5. If possible, make the to graphs the same size. Font sizes for axis labels and explanations are too small. Use same font in the charts, and for the A and B letters. Delete reticule. (A) Why using bins of different sizes? What was the rationale for selection the size of the bins?

A: Corrected. Explanation of bins given in the 2nd question.

Q: Figure 6. Use the same font used in the other figures. Font sizes for axis labels and explanations are too small. Delete reticule. Q: Figure 7. Use the same font used in the other figures. Font sizes for axis labels and explanations are too small. Delete reticule.

A: Corrected

Q: Figure 8. This is a very important Figure. I suggest enlarging it, as much as possible. For a better understanding of the results, all the different sections should be shown at the same scale. No need to repeat the legend in all the sections. The map can be simplified. In each section, the upper map shows the presence (1, red) or the absence (0, green) or cliff failures. This same information can be shown e.g., with a black dot inside each terrain unit of the susceptibility map. Where the dot is shown, cliff failure =1, where the dot is not shown, cliff failures = 0. This can save a considerable amount of space, and allow for larger figures.

A: The different sections were prepared at the same scale, but the figures were made for NHESS portrait layout and suffered different reduction in NHESSD format. The figures can be viewed at 300% which enables a detailed analysis of the LR model against the inventory. However, to improve observation of results, the suggestion is accepted and a new figure was prepared.

Q: Minor language copy editing suggestions: Page 1966, Lines 22-23: Use . . . are the dominant and more visible process of sea cliff retreat (Trenhaile, 1987; Sunamura, 1992), a significant source of natural hazard, and a constraint. Page 1967, lines 4: Use . . . for exceptional location building areas for houses, beach and leisure resorts. Locations over cliff tops . . .

A: Corrected

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 1, 1965, 2013.