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Comment

Interactive comment on “Assessment of physical vulnerability of buildings and analysis of landslide risk at the municipal scale – application to the Loures municipality, Portugal” by C. Guillard-Gonçalves et al.

Anonymous Referee #1

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General comments:

The paper presents a methodology for landslide vulnerability and risk assessment of buildings applicable at municipal scale. The topic addressed is scientifically relevant, of interest for the research community, and within the scope of NHESS. The scientific approaches and methods are valid; however, the obtained results are not discussed in a balanced, comprehensive way. The effort of measuring variability around the expert-based estimate of the mean vulnerability values is not innovative but commendable;

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Discussion Paper



however, it is not clearly explained how this measure of dispersion relates with uncertainty and how the latter is defined. The paper would also benefit greatly if the basic assumptions and limitations of methods are clearly explained and interpreted in relation to each component of the risk analysis framework (i.e. vulnerability, hazard, economic value). Moreover, to maximize the significance of the research, I strongly suggest writing the Results and Discussion sections separately, so that the synthesis and interpretation of the most important findings, description of study limitations and implications, including future research recommendations are better addressed. The presentation quality of data and results can also be improved with minimum of effort. Lastly, the level of English is generally good; however the language and use of some expressions is sometimes ambiguous. If possible, please ask a native speaker to review the text. Given these considerations (as well as the specific comments & technical corrections below), I suggest the paper to be reconsidered for publication in NHESS after major revisions.

Specific comments:

Abstract:

1. The abstract is concise and reflects the summary of the paper. However, it lacks a short interpretation of the most important finding (also for hazard and vulnerability) and the main conclusion. Please simplify and reduce the text where necessary (e.g. “the economic value of the buildings of. . . was calculated” can be reduced to “the economic value was calculated. . .”)
2. The use of standard deviation to measure the variability of the mean vulnerability value in expert-based studies is not innovative: see Winter et al. 2014, An expert judgment approach to determining the physical vulnerability of roads to debris flow, Bull. Eng. Geol. Environ. 73: 291 – 305, DOI 10.1007/s10064-014-0570-3. Please consider referencing this resource
3. Line 8: “The generalization of the vulnerability to the smallest statistical subsection

was validated ...” – it is not very clear what it is meant by “generalization of vulnerability”; the results of the first method can only be compared with the results of the second, more precise one (not validated, since these are no real observations, but model outputs as well)

Introduction:

4. Line 19 – 20, p.5548: Landslides do not need to occur in constructed areas to cause damage, it is sufficient to impact them to result in economic loss

5. This section needs to be better structured, paragraphs better related, language clearer; for example, lines 9 – 21, p.5549: landslide types, predisposing and triggering factors, as well as position of the elements at risk are discussed in a rather superficial manner and without relating them clearly with landslide vulnerability; line 18 - it is not obvious what is meant by “effects” of elements at risk position and why is this a source of uncertainty

6. Key terminology needs to be clearly defined and referenced from the onset (e.g. risk, hazard, uncertainty, element at risk value)

7. Lines 22 – 29, p.5549: the study of Papathoma-Köhle et al. 2007 states that buildings were assessed only in the medium and high susceptibility areas not mainly because the data were scarce – as this paper states, but also “for the ease of demonstration” (see original paper, p. 767). The methodology was applied in Lichtenstein, a community in the Swabian Alb and not at regional scale – the spatial scale this paragraph is discussing. Please be precise and clear while referencing and making assertions. The concluding sentence in this paragraph refers to landslide risk, although this hasn't been addressed so far (what do you mean by “in its whole”?)

8. Lines 7 – 9, p.5550: please reference the original author of the vulnerability definition used in this study (and not a research project, who adopted it as well from the same author)

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9. Line 4, p.5550: “many vulnerability models. . .” – the paper mentions uncertainty in vulnerability models that have not yet been presented/described

10. Line 11, p.5550: landslide intensity and magnitude are not synonymous (see Li et al. 2010, Quantitative vulnerability estimation for scenario-based landslide hazards, Landslides 7:125 – 134, DOI 10.1007/s10346-009-0190-3)

11. Line 24, p.5550: “Some few. . .” – can you support this assertion with a referenced study or investigation results?

12. Line 20 – 23, p.5551: The authors seem to disregard the fact that methods used in vulnerability assessment can and should be selected according to the scope of the study (incl. the level of spatial detail requested). Regional multi-dimensional vulnerability assessments can be performed using qualitative or semi-quantitative models in which uncertainty can also be addressed

13. Line 25, p.5551: “municipal or regional scale” – “or” implies the two are synonymous (see line 12, p.5552 as well)

14. The synopsis of literature can be improved; please write a brief summary of the most relevant studies for building risk to landslides as well; please indicate limitations and research gaps in previous research this study will address

Study area:

15. Please indicate if damages to built environment have been registered in the area in the past; also, a short characterization of the building stock and landslide types would help the reader to better understand the potential risk context

16. Line 19, p.5552: Please indicate the complete reference source

Data and methods:

17. Please consider shortening and simplifying the title of each sub-section. It would be helpful if the methodological steps (from vulnerability assessment to risk analysis)

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Interactive Discussion

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can be explained in a short paragraph at the onset of the section

18. Line 11, p.5553: please indicate the velocities associated with each landslide type

19. Line 19 - 25, p.5553: age, number of floors, structural type, etc. are not proxies for building foundation but indicators of building resistance capacity or susceptibility of being damaged due to the impact of a landslide

20. I suggest to write the paragraph describing landslide types and hazard intensity scenarios and proxies (depth of slip surface, height of accumulated material) before the vulnerability matrix section

21. Line 7, p.5554: what do you mean by “typical landslide parameters”? Please argue clearly why those nine landslide scenarios were selected (and no other slip surface depths or accumulation heights), and what building damage patterns are expected or can be associated with each scenario (check the relevant literature for observations on different structural building types)

22. Line 13, p. 5554: how relevant is to send such a specific questionnaire to experts in “other natural risks”?

23. Line 9 – 11, p.5554: I suggest to rephrase describing differences between vulnerability models (quantitative vs. qualitative or semi-quantitative); the statement is too general

24. Please argue the use of slip surface depth as proxy for landslide destructive capacity/intensity (see also comment 10 for the use of landslide magnitude vs intensity)

25. I suggest to add the questionnaire (matrix) as annex to the paper, if there is no sufficient space in this section

26. Standard deviation is a measure of variability around the estimate of the mean vulnerability value; this shows how much the experts were in (dis-)agreement about the vulnerability of a building type for a given hazard scenario; however, it does not

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Interactive Discussion

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give any indication of the accuracy of their answers (i.e. how close where they to the real, true value given their different backgrounds (see comment 22), etc. Please define clearly what you mean by “uncertainty” and to which extent you are able to address it (from the onset – Introduction)

27. Line 14 – 19, p.5555: The classification of the building stock should be described in detail at the onset of the vulnerability section; what do you mean by “type of construction”?

28. Line 24, p.5555: Please indicate a mathematical expression for the calculation of the weighted average vulnerability per BGRI-subsection

29. Line 1-2, p.5556: Can you give an indication (relative or absolute number) of what you mean by “most (of the BGRI)” and “large (number of buildings)”?

30. Line 7-8, p.5556: please modify the text in accordance with suggestions from comment 26

31. Line 16, p. 5556: please state clearly what are the “relevant building characteristics”

32. Section 3.1.3: This sub-section should focus on the method of field data collection, the selection criteria of building characteristics, the vulnerability assessment model (method) used

33. Line 19, p. 5556: what do you mean by “type of urbanization”?

34. Line 23 – 24, p. 5556: there are two methods (with different mapping units) in one single study and not two studies

35. Line 24, p. 5556: please replace the term “cost-benefit ratio” with a less pretentious one if an actual cost-benefit analysis is not performed

36. Line 20, p.5558: rotational (deep-seated and shallow) landslides?

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Interactive Discussion

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37. Line 24, p.5558: please indicate the mathematical function characterizing the relationship between the landslide depth and area, and explain the similarities between the two landslide datasets

38. Lines 3 – 5, p.5560: please indicate the reference sources

Results and discussion:

39. I strongly suggest to split this section in two (one for the results, the other, an extensive discussion and interpretation of the results)

40. The knowledge of the study area is maybe less important as the research background and experience of the interviewed experts; please state their research background

41. Lines 1-2, p.5562: one would expect that a wooden or metal building impacted by a 5 m landslide material would actually be totally damaged (or associated with an average vulnerability higher than 0.94). Can you please discuss the expert based values in relation with the vulnerability values estimated in the literature for the same type of structural buildings?

42. Table 2: do vulnerability values represent the upper bound associated with each damage class? If so, what is the lower bound?

43. Lines 6 – 9, p.5562: what would be the implications of these results for the final calculation of risk?

44. Section 4.1.2: The interpretation of results is very crude. Please be more specific in explaining the differences in vulnerability values associated with each damage stage and depth of slip surface/accumulated material height (see also comment 24)

45. The literature on buildings vulnerability assessed using height of the accumulated material and structural type can be consulted and used here for comparison

46. Section 4.1.3: the reader does not know what method (empirical, heuristic, nu-

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merical ,etc.) was used to compute vulnerability at individual building level nor what indicators (building characteristics) were incorporated into the model (how where the vulnerability values at building level obtained?); thus, the comparison with the BGRI-scale method is ineffective and the assertion of accuracy validation for the first method questioned

47. The use of the Cartesian system is confusing; I suggest to split Fig. 8 and Fig. 15 in two, and actually use the Y-axis for the slide slip surface depth values and material height separately, or inverse the two parts of the graph, showing on the negative Y axis the depth of slip surface, and on the positive Y axis the height of material. Please also check the correctness (completeness of Fig. 8), the inter-quartile ranges seem to miss the median line and one box is even missing

48. Line 3, p.5564: what do you mean by “reproducible”?

49. Please indicate the source of Fig. 10 in the caption as well; the same for Fig. 11 and 12 (indicating they are based on the work done by Guillard and Zezere, 2012)

50. Section 4.3.2 (and associated figures/tables): decimal numbers should be limited to maximum 2. Where necessary, use scientific notation (negative exponent of 10 for very small numbers)

51. Lines 9 – 12, p.5566: Please explain the implications of the methodological limitations for the risk calculation

52. Section 4.4: Fig. 13: please use the notation Risk (€pixel) and indicate the pixel size in caption

53. Wasn't there any information loss during the transformation of buildings from vector to raster? How does that influence the risk estimates?

54. Fig. 15: please indicate the value of the outliers in the figure caption as well

55. Please consider increasing the size of figures 13, 14, 16

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Interactive Discussion

Discussion Paper



56. It is rather difficult to relate with economic risk at pixel size only; I suggest, if possible presenting the risk associated with different time period for each civil parish as total economic risk per administrative unit (since at BGRI-subsection it might be too time consuming). This way a comparison at administrative level might be easier to evaluate and interpret

Conclusions:

57. Part of the text under this section belongs to a discussion section (with much more in depth interpretation and considering the suggestions above)

58. Line 1 – 3, p. 5569: if the value of building's content is included in the assessment, it might change significantly the modeled vulnerability value but the real capacity of the building to resist the impact of a landslide would be the same; therefore I don't consider the exclusion of contents value in the analysis a limitation

59. Please indicate the significance of the contribution of this study to the research field and possible practical applications

- Please consider rephrasing the ambiguous or imprecise expressions in the text: e.g. line 1, p.5548: "the study offers", line 9, p.5548: "expensive damage", line 19, p.5549: "course of landslide", line 29, p.5549: "analyzed in its whole", "building belonging to a landslide body", etc. (please ask a native English speaker to review the text)

- Please look through all figure captions and simplify them if possible

Technical corrections:

- Faulty referencing style: line 24, p.5548: Varnes and IAEG, 1984

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