

Interactive comment on “Assessing population exposure for landslide risk analysis using dasymetric cartography” by R. A. C. Garcia et al.

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Authors Reply to RC1 – M. Papathoma-Koehle Interactive comment on: “Assessing population exposure for landslide risk analysis using dasymetric cartography” by Garcia R.A.C. et al.

1 General comments The authors present a methodology used for dasymetric exposure mapping of population applied in Portugal that can be used from emergency managers to guide evacuation and rescue operations. The disaggregation of population data in order to get a more realistic picture of the population density (especially during different times of the day and the year) and eventually the exposure is very important for the design of emergency operations. However, the specific does not present the methodology used in a comprehensive way due to poor structure and poor English.

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The article needs restructuring, rewriting of the discussion section giving emphasis in the assumptions and uncertainties and a final editing from a native speaker who can significantly improve the language. For this reason I do not think that it should be accepted for publication in its present form.

A.Reply: The authors would like to acknowledge the referee for the deep review of the manuscript and by the constructive comments that will contribute to improve our manuscript. All the comments and suggestions will be considered in the new version of the manuscript and will be discussed individually in our reply to referee. In addition, the new version of the manuscript will be subjected to a final editing made by a native speaker.

Specific comments

2 -Abstract: Abbreviations such as BCU (line 12) have to be explained at the beginning

A.Reply: The comment will be taken into consideration and we will remove the acronym from the abstract. The sentence in the abstract will be changed as follows: "...as spatial units, the basic census units that is the more detailed data available for regional studies in Portugal"

3-Abstract: it needs rewriting to improve the language. Grammatical mistakes and total lack of punctuation (commas) make the article difficult to read and understand. This is relevant also for the rest of the text.

A.Reply: The authors understand the reviewer comment and apologize for that. Indeed, we hired a specialized translation service to an English native speaker to review the complete final manuscript in order to avoid spelling and grammatical errors.

4-Introduction: The introduction is disproportionally long in comparison with the other chapters. The authors provide a literature review (which is good) but although they explain thoroughly what risk is they do not do the same for other terms that are often used in the manuscript such as "exposure" or "dasymeric mapping". A good idea

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would be to divided in sub-chapters (objectives, state of the art etc.)

A.Reply: We acknowledge the referee comment and suggestion. Therefore, Introduction will be split in sub-chapters to make it clear. Disproportionality with other chapters will be taken into consideration but it will decrease with the increasing size of study area, methodology, results and discussion sections. Additionally, definitions about some frequently used terms will be added/referred in introduction as: Exposed elements- considered as elements present in hazard zones that are thereby subject to potential losses (e.g. UNISDR, 2009) Dasymetric mapping – a mapping technic that use ancillary information to turn into a finer resolution coarser input data Susceptibility – considered as the likelihood of landslide occurrence in a specific area according to terrain conditions (Brabb, 1984)

New references in the manuscript:

Brabb, E. E.: Innovative Approaches to Landslide Hazard and Risk Mapping, In: Proceedings 4th International Symposium on Landslides, Toronto, Canadian Geotechnical Society, 1: 307–323, 1984.

UNISDR: 2009 UNISDR Terminology on Disaster Risk Reduction, Int. Strat. Disaster Reduct., 1–30, doi:978-600-6937-11-3, 2009

5-Study area: Here a new piece of information appears regarding the landslide susceptibility map. Is this done by the authors? (Apparently, yes)

A.Reply: We appreciate the comment. In fact the susceptibility map was developed by the first author in his PhD thesis. A reference to the authorship of the landslide susceptibility model will be made in the new version of the manuscript.

6 -Study area: Why are you working in this area? Past events? Consequences?

A.Reply: The authors acknowledge the reviewer comment. The study area is part of the Alenquer municipality and is located in the area north of Lisbon, known as an important landslide prone area (Zêzere et al., 2008). The option for this study area was

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supported by three reasons: 1) landslides incidence; 2) type of urban occupation; and 3) social vulnerability. 1) The study area is located in the north of Lisbon region that is a landslide prone area (Zêzere et al., 2008) and according to the DISASTER database (Zêzere et al., 2014), is one of the most import areas in Portugal, considering landslide damage; 2) Additionally, the study area, presents two types of “urban landuse”: small villages with a “dense” urban grid as well as disperse settlements. Once the Census units boundaries where quite influenced by settlements density the presence in the study area of two different kinds of territorial occupations allow the comparison of the proposed methodology in two different urban contexts; 3) Moreover, Mendes et al. (2010) in a social vulnerability study for Portugal at municipal scale evaluate the Alenquer municipality as medium criticality (“...defined as the ensemble of individuals’ characteristics and behaviours that may contribute to the system’s rupture”) and Low capability (“defined as the set of territorial infrastructure that enables the community to react in case of disaster”). With this combination the Alenquer municipally is, theoretically, in the region north of Lisbon affected by landslides, one of the least capable to manage hazard consequences; This information will be inserted in the new version of the manuscript.

New references in the manuscript:

Mendes, J. M., Tavares, A. O., Freiria, S. and Cunha, L.: Social vulnerability to natural and technological hazards: The relevance of scale, in Reliability, Risk and Safety: Theory and Applications, vol. 1, edited by R. Briš, C. Guedes Soares, and S. Martorell, pp. 445–451, Taylor & Francis Group, London. [online] Available from: [https://estudogeral.sib.uc.pt/jspui/bitstream/10316/25442/1/JMM Esrel 2010.pdf](https://estudogeral.sib.uc.pt/jspui/bitstream/10316/25442/1/JMM%20Esrel%202010.pdf), 2010.

Zêzere, J. L., Pereira, S., Tavares, A. O., Bateira, C., Trigo, R. M., Quaresma, I., Santos, P. P., Santos, M. and Verde, J.: DISASTER: a GIS database on hydro-geomorphologic disasters in Portugal, *Nat. Hazards*, 72(2), 503–532, doi:10.1007/s11069-013-1018-y, 2014.

7-Methodology: (i) The methodology is not thoroughly explained (not at least in this chapter). The two approaches that you refer to in the following chapters should be explained here (ii). More information on obtained data could also be included here.

A.Reply: The authors thanks the referee comments but, with due respect, we think that is a little misunderstanding because the two chapters that the referee talk about (landslide susceptibility and population exposure) are in fact sub-chapters (3.1 and 3.2) of the Data and methodology chapter (3). Despite of that we will clarify the complete methodological process. Changes in figure 2 (general methodological approach), scale and source of building maps, and criteria for classification of residential buildings will be added in the new version of the manuscript.

8-Landslide susceptibility: (line 19). Why did you choose this classification method? What implications does this decisions have for the reliability of the results. This and other points should be discussed in the discussion chapter.

A.Reply: The authors totally agree with the referee comment. In fact, the used method to classify susceptibility map as well as the chosen number of classes can change the obtained results, once exposed population will have different distributions per susceptibility class. However, the focus of this work is not to compare different classification methods or different number of susceptibility classes on exposition results. Additionally, the option for the classification based on a quantile method aims to get susceptibility classes with similar sizes and thus not under- or over-value the importance of any of those classes. Nevertheless, this source of uncertainty will be referred in Discussion section. In addition, we made a test to evaluate changes in obtained results depending on the generalization from raster to statistical terrain units:1) the majority susceptibility value of each statistical unit; 2) the mean susceptibility value of each statistical unit. This will be included in the new version of the manuscript. Therefore, 3 different susceptibility maps and three different exposed population distributions were obtained. The obtained results reveal that the generalization methods significantly influence the importance of each susceptibility class. However, the advantage of the dasymetric

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cartography approach to assess the number of inhabitants still remains a good option. Results and Discussion sections will be added with tables and text about these topics.

9-Population exposure: (line 27-line 31) The authors explain here what a dasymetric method is. I think this belongs to the methodology chapter.

A.Reply: Data and methodology chapter (3) include in fact sub-chapters 3.1 and 3.2 devoted to landslide susceptibility and population exposure methodological information, respectively.

10- In the previous two chapters (landslide susceptibility and population exposure) a number of points show up that increase uncertainty and need to be discussed in the discussion chapter. For example: 1. classification of landslide susceptibility 2. Section 3.1, line 22: "The landslide susceptibility classification attributed to each BCU was defined according to the majority landslide susceptibility class represented in the BCU"-What implications does such an assumption have to the uncertainties related to this study? 3. Criteria for the binary analysis. (residential/non-residential buildings) 4. Weighting: this also belongs in my opinion to the methodology. Who decides on the weighting and using which criteria? This is not clear... 5. Page 6, line 26. "...target zones from vector to raster...". How can this information be used by emergency planners? Wouldn't it be more practical for them to have exposure information per building?

A.Reply: The authors acknowledge referee comments and all these topics will be added to the newer version of the manuscript. 1) this will be discussed in the new version of the manuscript as referred in our previous reply; 2) tests considering two different methods were done, as described in our previous reply; 3) vector building maps have attribute fields that allows differentiating some type of buildings (e.g. police stations, fire stations, schools, court, medical facilities, among others). Additionally, during detailed field work other buildings were identified as storage buildings or factory buildings. However, some buildings could have more than one use. In the present

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work all the buildings exclusively residential (93%) or mainly residential (5%) were considered as ancillary information. For the remaining buildings there were not assigned population. This information will be included in the new version of the manuscript. 4) The weighting is inserted on methodology. In the first version of the manuscript was presented a general weighting formula that can be used in dasymetric cartography. However, we recognize that in the present work only building area is available to use as ancillary information to weight the importance of buildings. To make it clear we will remove from methodology the general formula (with several parameters) and any reference to other parameters that can be used to weight target zones. 5) The conversion of the target zones from vector to a grid structure was only made to the assessment of the number of people exposed in each susceptibility class and therefore to easily compare the results obtained with approaches #1 and #2. Of course, we agree this information is not useful to Civil Protection. A map where inhabitants are addressed to each specific building should be provided for Civil Protection end users. This will be discussed and a new figure will be inserted in the new version of the manuscript.

11 -Page 7, lines 23-24, Revise the sentence. It makes no sense.

A.Reply: It will be done, it was a tip.

12-Discussion: The discussion needs rewriting and strengthening. The authors do refer to limitations and advantages but just superficially. The specific study includes a large number of assumptions and uncertainties and each one of them has to be outlined. The advantages have to be illustrated by “examples” on how the results may be used by the emergency planners. Moreover, many issues are completely ignored (e.g. presence of vulnerable groups: the division between residential/non residential is not thoroughly explained).

A.Reply: As written above many of the topics will be added to Discussion section (e.g. influence of the susceptibility classification method, generalizations method, use of not exclusively residential buildings). Although the aim of the present work is only to assess

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the number of inhabitants potentially exposed to a specific hazard, the new version of the manuscript will include reference to other topics that significantly influence the real exposure of people to landslide hazard. Topics as degree of people vulnerability due to their characteristics (e.g. mobility, age, education, number of year living on that place, etc.), due to building resistance, access to buildings or access to infrastructures and facilities (e.g. sewerage, water or electricity supply, medical care, etc.) will be included in Discussion section

13- The authors need a conclusion chapter, outlining their achievements and describing the future perspectives in the specific field.

A.Reply: The referee suggestion will be take in account and a Conclusion section will be included in the new version of the manuscript.

14 Technical corrections Native speaker editing is in my opinion necessary. There are plenty of grammatical mistakes, inconsistent language (approach 1, approach 2?), mistakes in wording e.g. “study case” (instead of case study), “building limits” instead of building footprint, “people inhabitants etc. and parts that are difficult to understand (e.g. “turn off Lisbon metropolitan area”). The lack of commas makes also the understanding of the text very difficult.

A.Reply: The authors apologize for those mistakes and a specialized translation to an English native speaker is appointed to review the final version of the manuscript.

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