Natural Hazards
and Earth System
Sciences
Discussions

Interactive comment on "Potential future exposure of European land transport infrastructure to rainfall-induced landslides throughout the 21st century" *by* Matthias Schlögl and Christoph Matulla

Matthias Schlögl and Christoph Matulla

matthias.schloegl@ait.ac.at

We would like to thank the referee for the evaluation of our manuscript and the provided feedback. Please find our responses below, with referee comments in italics, and authors' responses in standard format.

1 GENERAL COMMENT

The article presents an evaluation of possible future variations in the overcoming of an already-defined rainfall threshold for landslide occurrence in Central Europe, as a result of the application of an ensemble of downscaled climate projections, with particular regard to roads and railways. The paper is clear, sufficiently well-written and potentially publishable. It follows somehow the IMRaD structure, even if with some drawbacks, that should be improved. The English language is good. In my opinion, the manuscript needs major revisions before being accepted for publication, for several reasons listed below.

- *Mainly, the theoretical background and the proposed method are not well defined. In particular, the definition of the climate index is not well explained in the text (it can be deduced after reading the results), and the procedure for obtaining the maps of changes in threshold exceedance related to infrastructures are not clear.*

  We would like to thank the reviewer for pointing this out. The methods section has indeed some room for improvement. We will rework this section in order to provide a more concise and clear description of the methods employed. In particular, we will describe the definition of the climate index as well as the procedure for obtaining the maps.

- *Moreover, is not explained how the Authors used the information contained in the maps of slope, TRI, geology, soil types, rainfall erosivity, and CLC. These maps were used only for comparison with the obtained results? Or they were used also in the calculations? This should be explained.*

  The maps have been used to support the discussion of the implications of meteorological impacts imposed by the CI in a more practical/realistic context. They

were not used for the calculation of the CI or the results presented in maps 1 and 2. We will clarify this in the text.

- *In several parts of the manuscript, Authors refer both to "landslides" and "landslide events". I would suggest to define what a "landslide event" is or to use the simple "landslide".*

We will replace "landslide event" with "landslide" throughout the text in order to avoid confusion in this respect.

- *If I have well understood, Authors are referring on threshold overcoming as climate index for landslide occurrence. That's true? If yes, this should be reported and defined clearly in the text.*

Yes, this is correct. We will clarify this in the text.

- *Moreover, several toponyms and names of regions are reported in the text. A map with all those names (also as supplementary material) would be useful for non-Europeans readers. At least, I suggest adding the names of the Countries in which the cited regions are located (e.g., Alsace, France).*

Thank you for pointing this out. We will provide a supplementary map containing all toponyms as proposed by the reviewer.

- *For what concern the structure of the paper, the "Introduction" section is not very easy- to-read. At the beginning there is a summary of the work (lines 3-6), which should be better located and the end of the section.*

We will move the respective part to the end of the section. In addition, the introduction will be reworked in order to be better readable.

- *The "Data" section is good, but another subsection with details about other used data could be appreciated.*

C3

We will add another subsection covering all other data sources used for figures 5 and 6.

- *The "Method" section is not clear. The definition of the climate index is not effective and the procedure used to pass from whole maps to infrastructure maps should be better described. Moreover, the cited work made by Matulla et al. (2017) present a very similar approach and similar results. Thus, differences and improvements proposed in this new paper should be strongly described.*

We will rework the methods section. We will add more precise information on the CI and the procedure of deriving the infrastructure maps from the gridded data sets. We will point out the improvements of this work compared to the work by Matulla et al., 2017.

- *The "Results and Discussion" section is well-structured. However, two subsection could be added, referring to "Central Europe" and "Target area".*

We will add these two subsections.

- *The "Outlook" section should be reworded, presenting the main findings and innovations of the work, and not only the future developments.*

We will rework the outlook section by including the main findings and innovations of the present work as proposed by the reviewer.

- *The reference list is complete, and all the articles are cited in the text.*

2 SPECIFIC COMMENTS

- *The abstract should be shortened, particularly in the parts at lines 1-8 and 20-25.*

We will shorten the abstract to be more concise, particularly the parts mentioned by the reviewer.

C4

- *The Central European region should be geographically defined.*

  We will define the region at the beginning of the proposed subsection 4.1.

- *Please, for a good understanding, add letters (a, b, . . .) in the panels of all figures. Consequently, add information in the captions. As an example, the text reported at page 5, lines 5-6 (The first row of each figure refers to the near future, the second row displays projection results for the remote future. The three columns represent the quartiles in increasing order respectively) should be better written in the caption of Figure 1. The same for the other figures.*

  We will rework the figures and their captions accordingly.

- *Table 1 could be changed in two tables: one referring to values related to roads, and another with values related to railways. In the caption, just mention the CI, without re- peating the threshold values.* While table 1 could indeed be changed into two tables, differences in the resulting summary statistics for road and railway network deviate only to a minor extent. The underlying climatological raster data sets are the same and both road and railway networks are quite dense in Central Europe. We would therefore suggest to keep one table, since the additional information gained by splitting the table into two tables is negligible, as both tables will look very similar.

  We will adjust the caption accordingly.

- *I suggest moving to the method section the text reported at page 8 lines 6-9 and lines 15-20.*

  We will move the paragraphs as proposed by the reviewer.

- *Figure 6b: I suggest considering only the second level of the CLC classification. Please be sure that all the characters in the figures will be readable.*

  We have decided to use all three levels of CLC in order to provide a consistent

land cover image. We have used the official legend and color coding for CLC level 3. By using only level 2, we would need to define custom colors for each level, which will lead to inconsistencies with other CLC maps.

- *Please check the text and correct some typos and errors in referencing in the text.*
  We will double-check the whole text in this respect.

- *Finally, I would suggest some works dealing with: i) climate change and infrastructures (Loveridge et al., 2010); ii) landslide hazard and risk hotspots in Europe (Jaedicke et al., 2014); iii) effects of environmental changes on landslide occurrence (Begueria, 2006; Gariano et al., 2017), on susceptibility evaluations (Van Den Eeckhaut et al., 2012; Pisano et al., 2017), and on risk analysis (Papathoma-Köhle and Glade, 2013; Promper et al., 2014).*

  We will consider including these references where appropriate.

3 TECHNICAL CORRECTIONS

All technical corrections will be implemented/corrected as proposed by the reviewer.