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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Direct flood risk assessment of the European road network: an object-based approach" *by* Kees C. H. van Ginkel et al.

Anonymous Referee #1

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General comments:

Overall, this is a good study with a lot of detail, and it is a well-written paper. I therefore have only a few overall recommendations, as well as detailed suggestions for corrections or adjustments to the text.

I am missing a few contextual issues: first of all, this study is looking at large scale river flooding. In many European countries, there are substantial issues with local flooding and coastal erosion, as well as flash floods damaging roads and railway lines, such as in the Alps. The paper could discuss these impacts as well, and stress the relevance of the current analysis and findings for studying these hazards and risks. In

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this context, I am also missing an integral look at costs for road owners. The study covers inundation damages, but issues like erosion, scour under bridges and impacts on secondary infrastructure seems to be omitted.

Second, the largest losses are arguably the delays, and indirect effects caused by the disruptions. This could be discussed in the introduction. Now the focus is heavily on the repair costs, it seems.

Third, roads are mentioned in this study in a rather casual way, while in fact there are many different classes of roads, with different construction and damage costs, as well as agencies responsible for their maintenance and investments. As major classes national (highways), regional roads, and local roads stand out. I would welcome some discussion in the paper (for instance in Section 2) on this in relation to 1) the data for these classes included in CORINE, LUISA, and the object-based data from OSM; 2) how these differences are treated in the damage modelling (different curves as described in the supplement).

Fourth, and moreover, this study on damages stands in contrast to more broad vulnerability assessments approaches that have been developed over the past years. Surprisingly, no references is made to the ROADAPT project, that has done extensive work on flooding and other climate-related threats, including vulnerability modelling for highway infrastructure. This work also has had a major impact on public policy related to road infrastructure with national highway authorities. Here, in particular the vulnerability assessment in part C (Falema et al. 2014) is relevant:

https://www.cedr.eu/download/other_public_files/research_programme/call_2012/climate_change/roadapt/ROADAPT_Par
_guidelines_on_vulnerability_assessment_method.pdf

I would expect the authors to place their work in the broader context of risk assessments for roads, and how this adds/complements to methods such as ROADAPT VA.

Finally, I really appreciate the large image at the end of the Supplement with exposed

road segments. However, it would be even better (also in the context of the EU funding of the work) if the authors would make this and other data available digitally in a repository. I would urge the authors to include a section on data and code availability.

Below, I provide several further questions and textual suggestions, which I hope are sueful for improving the manuscript.

Specific comments:

Page 1, Line 24: please replace “risk adaptation” either by “risk reduction” or “adaptation”.

Page 1, Lines 31-32: Please explain why it is an important issue, also keeping in mind my general remarks, above.

Page 2, Line 37-42: It is unclear here what the implication is. In principle, when surface area is correctly accounted for, a grid of 100x100 meter could contain accurate information on the share and characteristics of line-shaped infrastructure. In general, infrastructure damage is often overestimated in course grids, but this is rather due to the overestimation flood water depth and extent at the location of the infrastructure, which is often located at higher grounds. Please provide a more detailed discussion of the issues here, as now it is unclear what you mean.

Page 2, Lines 53-54: This sentence should be rewritten. What I think is meant here, is not the gridded damage model, but the gridded exposure data, which is only one component. This should be made clear here, and also in other places, as the distinction does not go further (as far as I can assess). And then still, in many of the available models, objects are transferred to grids, to simplify computation, which performs equally well as vector-based computations. So what is probably meant here, is vector information on exposed infrastructure versus remote sensing or other gridded data on infrastructure, and their detail or accuracy.

Page 3, Lines 85-87: Please explain that flood risk here means: large scale river

flooding only.

Page 4, Line 126: Maybe you can briefly add why this is overlooked. Is this because the roads are not resolved or sufficiently classified as roads from remote sensing data, or because in the production of CORINE such information from member states is not included?

Page 5, Lines 133-136: This sentence is unclear to me: who has assumed these percentages? The producers of the CORINE dataset, or you? I would imagine, based on Tables S1 and S2 these are intrinsic to the data, but please explain this to the reader.

Page 5, Lines 155-156: But the study by Dottori et al. (2020) refers to the study by Ward et al. (2017, in Nature Climate Change) where e.g. the 100-year protection level associated with the corresponding water level is assumed. However, where does the data on current protection levels per country or river segment comes from, as stated in these lines? That is not clear to me.

Page 5, Footnote: Guadeloupe seems to be misspelled.

Page 6, Figure: What does the cm indicate in the main model panel? Are these inundation depths? But these vary across the sections, correct? I assume that per flooded grid cell, the length of road is exposed to a single inundation value over that length; perhaps this can be explained in the text. Now it seems as if some average is used, which would not work with non-linear damage functions. Also, I think what is called “metadata” in the figure are actually attributes of the vector files. Attributes is a common term in GIS, and I would propose to use this instead.

Page 7, Table 1: For Footnote A, I would also expect an adjustment for the Huizinga exposed values from m2 to road length, so accounting for both width and length, and only length is mentioned here.

Page 7, Lines 202-2011: It would be good to have a discussion at this point about what kind of costs are included in the function. Are these repair costs, or also clean-up

and other costs? Also, which repairs are estimated, only from the road surface or also other including erosion and adjacent infrastructure? Here, flow velocity also becomes an important point, in relation to what is said about the high and low estimates, on Pages 7 and 8 (Lines 212-223).

Page 12, Figure 5: What I would like to see is which NUTS areas have a high flood risk; that is, in which locations do you see many damages at low return periods. At the moment, it is not clear in this overall risk graph, which locations suffer from frequent small losses (e.g. Austria and Germany), and which locations have a very high loss only for very rare events (e.g. Netherlands, Belgium etc.). One additional figure at a well-chosen return period (e.g. 20 or 50 years), or a bar chart per country with losses per return period, would help in this regard.

Pages 14-15, Lines 381-409: I find the validation case not convincing. As you state, it cannot be expected that the Bavarian government had costs of only 3.8 million, as it is unlikely that the EU funded the repair costs in full. Until you have a good handle on the actual costs, you cannot really validate this case, and the conclusion that your model overestimates is not so well-supported. Are there not any better numbers on this case? Perhaps an additional sentence here would be usfeful.

Page 16, Lines 456-457: But you do not know the actual total costs; so I suggest to replace with “the estimated size of total damage costs for the validation event”.

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