Nat. Hazards Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/nhess-2018-295-AC2, 2019

Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Re-evaluating safety risks of multifunctional dikes with a probabilistic risk framework" *by* Richard Marijnissen et al.

Richard Marijnissen et al.

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Received and published: 11 February 2019

We would like to thank the reviewer for his/her thorough feedback on the paper. We are sure this feedback will be of great help during the revision and hope the reviewer will be satisfied with the changes.

General comments:

Comment 1: ... The manuscript is well-structured, presents a novel advancement of the methodology and reaches substantial conclusions. It is mostly well-written, though some sections need to be made clearer (see comments below). However, I believe the authors can further strongly improve the manuscript with regards to two aspects.

Response: We thank the reviewer for this comment. Indeed we think that by following

the suggestions the paper will improve.

Comment 2: (1) The section P7-L18-32 describes the effect of two additional functions (vegetation and build-structure) on dike stability. I found this description rather cryptic and unclear. It should be significantly improved. It is not clear, how either of the functions affects each breach mechanism. [1] Does the build structure affects only macro-instability due to additional weight? [2] Is there effect on piping, e.g. due to longer pipe length needed to induce a dike failure? [3] What do you mean by the insignificant amount of overtopping q<0.1 is acceptable? [4] What does this have to do with the structure or absence of a structure? [5] How one should imagine a scenario (with the annual probability of 1%), where a house disappears creating a hole at its location with the dike being intact (!). This is not clear to me.

Response: We agree that this section can be made clearer and plan to revise it based on this suggestion to make it clearer. The individual points are addressed here:

[1] The built structure is schematised by 2 effects in the model: 1) its additional weight and 2) a decrease in the maximum allowable overtopping rate.

[2] No, in our cases the structure does not extend into the aquifer and thus has little effect on piping. Furthermore one could argue the presence of a structure inhibits the well from emerging at the structure's location but a pipe could emerge just beside the structure instead along its outer wall.

[3] & [4] During overtopping the outer layer on the landward side of the dike should not erode during design conditions. When a structure is present it is effectively a discontinuity in the outer cover where water can more easily erode soil. This is reflected in a lower critical overtopping rate (q). When the structure is absent (see Table 1) there is presumed to be no grass cover but instead loose bare soil that will almost immediately start eroding. Since it is statistically impossible to rule out any overtopping (q=0 l/m/s) it is practise in the Netherlands to use q=0.1 l/m/s as a threshold value if effectively no erosion resistance can be expected and thus practically no overtopping is allowed

during design conditions.

[5] The situation considered is not necessarily a collapse of the structure, but can also be when the structure is removed temporarily (e.g. a renovation or demolished intentionally to construct another). See also our response to reviewer 1. We will make sure to clarify this distinction in the revision.

Comment 3: The second aspect is related to the first one and concerns the results of failure probability calculations (Fig. 5) and in particular the influence of different breach mechanisms. As the role of functions for various breach mechanisms was not clarified in details, it is very difficult to understand the effect of considering these functions on the distribution and changes of breach mechanisms presented in pie charts in Fig. 5. Unfortunately, the authors only scratch the surface and leave much of the presented results undiscussed and not analysed in-depth. I would appreciate a much more detailed analysis and discussion of the effects of (a) function failure and (b) reinforcement scenarios onto the role of breach mechanisms.

Response: We agree with reviewer 2 and we will explain this more in-depth by elaborating further on the reinforcements in section 3.4. Furthermore we plan to expand the results section to analyse the role of function failure for each of the reinforcement strategies as well as with additional figure(s).

Comment 4 Finally, the authors mention in the text that uncertainties where somehow considered by considering scenario 7 “Robust dike”. I did not understand this and do not see that uncertainties (of whatever nature) are considered here. Actually, the study is self-contained and there is no need to assess uncertainties as the probabilistic analysis already incorporates the uncertainties of various model parameters.

Response: Indeed this sentence and its message were unclear. It was shown in the calculations that as the reliability of the dike increases, the influence of the uncertainty introduced by the functions has less influence on the failure probability. As the robust dike has the highest reliability, this effect was most clearly visible through this dike. The

sentence will be revised.

Comment 5: Abstract is poorly written and is not self-explaining. L11-14 are unclear for someone who has not read the paper and comes with general, though profound knowledge on flood risk.

Response: Based on your and reviewer 1’s comment the abstract will be rewritten for the revision.

Comment 6: In overall, I rate this study as very solid and believe that after addressing the two major issues and a few minor comments below it can make an interesting and significant contribution to the research on probabilistic assessment of dike failures and flood risk assessment.

Response: We are happy with the comments and motivated to address the issues you have pointed out.

Minor issues

Comment 7: Introduction: The text is somewhat doggerel and needs a careful revision. (e,g, P1-L26-35 and comments below)

Response: The section between P1-L26-35 will be shortened to be more concise.

Comment 8: P1-L19: risk of floods is not increasing everywhere. One should differentiate. “these cataastrophes” – you are talking of risk in general and not about some specific catastrophes.

Response: While flood risks are in general increasing due to a combination of climate change (sea-level rise and extreme rainfall) and economic developments in deltas, I can imagine that in specific regions this is not the case. I will specify that only applies for a majority of flood prone regions. I will also replace the word catastrophes with floods for clarity.

Comment 9: P1-L21: “Risk based approaches have been” used not “performed”. L22:

remove “the” before “understanding”.

Response: Thank you for pointing out these corrections

Comment 10: P1-L36-37: revise the sentence.

Response: The sentence will be revised to: “Before the Dutch Water Act was revised the protection level of flood defences was defined only by the exceedance probability of extreme conditions which the flood defence is designed to withstand (Van der Most et al., 2014)”

Comment 11: P2-L1: Is this really true? The nation-wide risk assessment for England and Wales (Hall et al., 2003, 2005) also used probabilistic approach to assessment of protection level/failure probability.

Response: While a probabilistic approach was certainly used there, by our knowledge it was not legally required to do so. We will check this for the revision.

Comment 12: P2-L35: Reference Hinkel et al. is missing in the reference list.

Response: Hinkel et al. will be added to the reference list.

Comment 13: P3-L1: what is a ‘cohesive’ framework?

Response: The word should have been coherent, not cohesive. We will make the correction.

Comment 14: P3-L40 – P4-L1: as you mention, a conservative approach is usually taken assuming the NWO to be in the most critical state. Make clear that the actual probability of failure of the NWO is thus not considered.

Response: The word “actual” will been inserted to make this clear: “... because the actual probability of multifunctional elements being in a critical state is not considered”.

Comment 15: P4-L9ff: in general, it seems that the vast majority of literature sources used in the manuscript is of Dutch origin. Nevertheless, there is also some relevant

literature outside. E.g. the use of limit state functions and fault trees for flood defence assessment and hazard/risk assessment was performed by Kortenhaus (2003), Apel et al. (2004), Dawson & Hall (2006), Vorogushyn et al. (2009, 2010).

Response: Indeed we could have used more international sources. The majority of references are of Dutch origin as the starting point of the research was the Dutch guidelines and sources/studies to support them. We will look to incorporate some suggested literature in the revision.

Comment 16: P4-L28: what is WBI2017?

Response: WBI2017 is the official abbreviation of the current Dutch assessment tools. References to WBI2017 should be changed to “the official Dutch assessment framework for flood defences”

Comment 17: P5-L19: also Vorogushyn et al. (2009) compiled the statistics on dike failures from a few previous studies

Response: Thank you again for the suggested literature. We will try to incorporate the suggestion in the manuscript.

Comment 18: Eq.3.6: Use h=0 as the lower limit of the integral. –Inf dies not make sense for water levels.

Response: If h would refer to water depth the lower limit would indeed make more sense to be 0. However since h can be negative in some reference systems (e.g. -1m +MSL which would be 1m below Mean Sea Level), h=-Inf is appropriate here.

Comment 19: P8-L3: Is this correct that the effect of the function is limited in the scenario 2? The yellow bar is significantly lower than for the monofunctional assessment! At P7-L40 you mentioned that in the scenario 2 there is a significant positive effect of the structure. Please, check.

Response: As also pointed out by reviewer 1, this sentence should have referred to

profiles 0,1 and 5 not 0,1 and 2. It does not apply to 2 and 3 because here soil is replaced by additional weight of the structure leading to a net positive effect on stability. We will correct this.

Comment 20: P9-L29-30: The sentence and the message is unclear to me.

Response: The message was that before the new Water Act probabilistic assessments could be used but there was no obligation to do so. Now a probabilistic assessment is required and naturally more probabilistic assessments are being used. The sentence will be revised.

Comment 21: The list of references is not carefully formatted. Temmermann et al., journal missing.

Response: The journal will be added. Thank you for spotting this.

Comment 22: Move the equation for the Iribaren number from Table B1 into the B-section prior or after Eq. B10.

Response: The equation will be moved after Eq. B7.

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