Nat. Hazards Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/nhess-2018-295-RC2, 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.

**Anonymous Referee #2**

Received and published: 6 January 2019

The manuscript by Marijnissen et al. applies the probabilistic dike failure assessment framework to the multi-functional dikes. These dikes incorporate besides the genuine flood protection function other functional elements such as for instance natural vegetation and build structures (houses). The authors compare the probabilistic assessment of multi-functional dikes considering the failure probability of dikes due to overtopping, piping and macro-instability and also the probability of failure of additional functions to the mono-functional assessment and the conservative assessment. The latter considers the failure of additional functions (with the probability of 1) and represents the current engineering practice of failure probability assessment of multi-functional dikes. The analysis of various dike reinforcement scenarios in the presence of either a build-structure or vegetation or both suggests that the probabilistic assessment of



Printer-friendly version

Discussion paper

functions failure results in overall lower failure probability compared to the conservative approach. Compared to the mono-functional assessment the failure probability may be higher or lower for a multi-functional dike depending on the net positive or negative effect of the function and the interplay with the reinforcement measure. 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.

(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. Does the build structure affects only macro-instability due to additional weight? Is there effect on piping, e.g. due to longer pipe length needed to induce a dike failure? What do you mean by the insignificant amount of overtopping $q<0.1$ is acceptable? What does this have to do with the structure or absence of a structure? 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.

(2) 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.

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.

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.

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.

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

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.

P1-L21: “Risk based approaches have been” used not “performed”. L22: remove “the” before “understanding”.

P1-L36-37: revise the sentence.

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.

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

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

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.

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).

P4-L28: what is WBI2017?

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

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

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.

P9-L29-30: The sentence and the message is unclear to me. The list of references is not carefully formatted. Temmermann et al., journal missing. Move the quation for the Iribaren number from Table B1 into the B-section prior or after Eq. B10.

References:

Apel, H., Thieken, A. H., Merz, B., and Blöschl, G.: Flood risk assessment and associated uncertainty, Nat. Hazards Earth Syst. Sci., 4, 295–308, 2004.

Kortenhaus, A. (2003): Probabilistische Methoden für Nordseedeiche. Dissertation. TU Braunschweig, Germany.

Dawson, R. J. and Hall, J. W.: Adaptive importance sampling forrisk analy-

sis of complex infrastructure systems, Proc. R. Soc. A.,462, 3213–3499, doi:10.1098/rspa.2006.1720, 2006.

Vorogushyn, S., Merz, B., Apel, H., 2009. Development of dike fragility curves for piping and micro-instability breach mechanisms. Natural Hazards and Earth System Sciences 9, 1383–1401.

Vorogushyn, S., Merz, B., Lindenschmidt, K.-E., Apel, H., 2010. A new methodology for flood hazard assessment considering dike breaches. Water Resources Research 46, W08541. http://dx.doi.org/10.1029/2009WR008475.

---

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2018-295, 2018.



Printer-friendly version

Discussion paper