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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Levee reliability analyses for various flood return periods – a case study in Southern Taiwan" *by* W.-C. Huang et al.

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Dear reviewer, thank you for the review comments. The writing style may be revised accordingly in the revised manuscript for easier reading. For the scientific comments, please refer to the following responses for more details: (1) In the manuscript, overtopping was used to indicate that the water level exceeds the design levee height. However, as the reviewer suggested, wave can also contribute to overtopping of the levee, which is not the considered scenario in this study. Therefore, the authors will revise the wording from overtopping to overflow, as the reviewer suggested. Thank you. (2) Shallow geotechnical sliding failure is also one of the possible failure mechanisms for levees, however, we have considered the full levee breach as the failure mode in this

study because shallow geotechnical sliding may happen when the surficial cover material was not constructed or compacted well. In our analyses, shallow sliding failure can only occur when a very low shear strength of levee cover material exists, which may not be the actual case for the study case. In reality, once some part of the cover material is damaged (to floating debris), flood water may attack this part and deteriorate the levee. In this study, we have focused in full levee breach failure and assumed that the cover material was intact when the floodwater came. Although we have made such assumption and the design cross section showed that the cover material was thin layer of concrete, shallow geotechnical sliding may still be one possible failure mechanism for other levees. We will revise the possible failure mechanisms in the manuscript to clear this part. (3) In this study, steady state seepage was considered in the analysis. Transient seepage is also one possible condition, especially when the water levels just changed, however, the mechanism is much more different for different kinds of backfill material. In this study, the backfill material is mostly gravel or sandy material, of which the steady state seepage may be reached within a very short time once the water levels changed. Therefore we consider the assumption of steady state seepage to be reasonable, however, the above description about transient seepage will be added to the manuscript for better understanding. (4) As for capillary effect, the same reason applies as mentioned in (3). The levee backfill material is mostly sandy or gravel material, therefore the effect of capillary may not be as obvious as fine material and therefore was not considered in the analyses. (5) Thank you for the suggestion. WLD and WLD coefficient may be mix-used in the manuscript. These terms will be modified in the manuscript accordingly. In addition, the normalization was based on the protected side water level (landside water level). There is a typo in the manuscript about the WLD coefficient definition, we will revise this part in the manuscript accordingly. One of the scenarios designed in this analysis was that the water rose at both sides of the levee to the design water height, and the flood side water receded. To show that the water level difference may be larger in a long return period flood event, the WLD coefficient was employed in the analysis by normalizing with the design flood water height. This is

easier to consider the normalization with only one number (just the landside water levels) than two changing numbers (i.e. waterside and landside water levels). (6) Thank you for the suggestion. The employment of flood side and protected side was based on the authors' experience. Landside and waterside is also clear for the readers. If necessary, the authors can add parentheses after the flood side and protected side with the suggested terms to avoid possible confusions. (7) Please refer to (5) for the discussion of WLD and WLD coefficient. To enhance the reader's comprehension, the authors agree that the terms will be explained again at proper location in the revised manuscript. (8) The mentioned scenario was one of the designed failure scenarios, and was indeed not realistic (no scour and high water). Therefore we have focused on the discussion of other scenarios, as mentioned in page 468 line 15 to 20 and line 27 in page 468 to line 4 in page 469. (9) Thank you for the comment. The results obtained using MCS were based on 5000 runs. In addition, we have also performed MCS based on 20000 runs, in which the results were similar with a much longer time. For example, under a flood return period of 100 year and WLD coefficient of 0.3, the probability of failure of slope sliding, retaining wall sliding and overturning are 100%, 14.63% and 0% under a 20000 run MCS. For the same return year and WLD condition, the probability of failure are 100%, 14.5% and 0% under a 5000 run MCS. (10) Thank you for the constructive comment. As mentioned previously in (5), WLD coefficient was defined as the water level difference divided by the landside water level (or the design water level). For long return period of flood, the term in the denominator (which is the design water level height) is larger than the one with a short return period. Under the same WLD coefficient with different flood return periods, it indicates that the water level difference is larger in a long return period flood. We think that the water level change may be more rapid and large in a long return period flood case, therefore the analysis results were discussed based on WLD coefficient. Although the absolute water level difference might be different for the same WLD coefficient of different flood return periods, the reliability indices are common terms that can be used to compare the reliability of levees for different flood return periods. The normalization of water level difference

may be more practical for engineers than giving a specific value of the water level difference because the calculated water level difference height under different designs of levees might have different values or trends of the reliability indices.

Thank you for the valuable comments and discussions about the above comments or new ones are welcome.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 457, 2015.