

Review of manuscript: *“Flood risk assessment due to cyclone induced dike breaching on coastal areas of Bangladesh”.*

Overview:

The paper has improved significantly in all of the three main points mentioned previously (message, methodology and English). This, along with the improved figures, gives the reader a much better understanding of the nature of the research. However, the problems with these areas have not been fully resolved. Despite the much improved manuscript, in my opinion these issues still require major revisions to the methodology and the message. However, methodological changes or extra data analyses are not necessarily needed to achieve a publishable article.

General Comments:

The improvements from the previous manuscript, as well as the continued (or new) problems I observe in the 3 areas mentioned above are described below;

Methodology:

The methodology is much clearer in the second manuscript, and helped by the flowchart. However, there are 3 aspects that need to be addressed.

The first is the differentiation between the 3 extreme scenarios the 72 scenarios. I previously suggested that a different name be given for these sets of scenarios, but this was not done, and it requires careful analysis for the reader to dissect this for themselves. The flowchart helps a little but it also causes more questions, which are listed in the specific comments below.

The second aspect is the fact that all the outputs relate to a 1:25yr event. Highlighting this more clearly would help the reader to understand the context of the research in terms of a wider flood risk analysis for the region, (see comments on message, below). A serious problem not addressed with the results of this calculation event is that the authors do not define for which temporal period risks are applicable. For example, if the results represent the current risk, then of the 72 simulations, those simulations with future SLR should not be included. For the risk in 2100 (the date at which the SLR value is predicted to happen), the simulations with current sea level should not be used. Furthermore, subsidence over time was accounted for to estimate the current topography, but not future topography. This is briefly mentioned in the conclusions, but not the significance for the results are not.

Finally the 1D modelling explanation needs to be improved, especially in terms of boundary conditions. Please see the specific comments below.

Message:

“The primary objective of the research was to present a methodology for generating FRM and PFM for the breaching of dike during a cyclone”. This line from the conclusion should have similar versions in the abstract and introduction, and in the opinion of this reviewer, should shape the overall message of the paper. It is also closer to the title of the paper. Instead the abstract and introduction sections describe the paper as “an investigation of the inundation pattern in a

protected area”, which is an interesting case-study, but not innovative or of interest to a general audience. For example, a line of logic for the introduction could be;

- Bangladesh is susceptible to cyclones;
- Damage estimates and flood maps, as well the identification of critical breaching locations, are useful for mitigating risk
- Quantifying this data requires taking account of SLR, cyclone frequency etc. and potential for breaching.
- A method to do so for the 1:25yr event (design criteria), for a particular polder, is given below.

Then, as well as the specific results, the applicability of the method to other areas and return period events could be estimated.

English:

This has improved significantly, but again, continued errors distract the reader, especially in the conclusion. The paper cannot be accepted with so many mistakes, and it is strongly suggested to ensure they are removed before resubmission.

Specific Comments:

Abstract

- P1, Line 14: “Scenarios were developed by considering... geometrical properties of the breach, breach propagation time...”. This line directly conflicts with P8, Line12: “As the geometry of the breach is not independent, it was not considered as a parameter for scenario development”. This was highlighted previously and needs to be resolved.

Introduction

- P2, Line 26: “Furthermore, by the year 2100 the annual estimated damage due to tropical cyclones may increase by US\$53 billion” This is surely due to the reasons the authors mention previously, and therefore not ‘furthermore’.
- P2, Line 26: “study area is not benefitted with...” This sounds strange.

Study Area

- P3: Lines 9-13: This part seems just like a list of data, and doesn’t connect well, consider revising.
- P4, figure 1: Please plot the extent of the dike on this map or on figure 3, as you mention it is only on the seaward side. Including the chainage points given in Figure 6 would also be useful.

Methodology

- P5, figure 2: The arrow from HEC-RAS to ‘Estimate damage’ during a loop is confusing. The output of 72 simulations from the loop should be used.
- P5, figure 2: Perhaps the damage and maps sections could be highlighted as outputs.
- P6, line 5: I don’t think the HEC-Ras description here needs to be so detailed. In fact this whole paragraph should be reviewed for structure and cohesion.
- P7, line 3-5: The English is poor here, and it is unclear. Are all cells rectangular? How can they have a single resolution or area? This is made more confusing by the grid representation in the figure.
- P7: Figure 3: Presumably Khaprabhanga is more of a channel than a river, as it seems to connect two parts of the Bay of Bengal. If this is the case it should be mentioned.
- P7: Figure 3: How are the upstream and downstream locations selected? Presumably it is because it is assumed a cyclone always come from the west and therefore imposes a water level downstream, but this is never stated.
If I am correct in this assumption of a water level timeseries as the main driver in the model, why wasn’t a QH relationship used at the other end? This raises a number of questions about the water level profile along the seafront.
Why was the Khaprabhanga included at all? No breaches occurred at that end, and it is not connected to the other 1D part.
- P7, line 16: Mangrove ForestS.
- P7: Line 17: “The storm surges...” English

- P8: Line 8: "...therefore, the wider and larger canals were included in the DEM". This sounds like the canals were 'burnt' into the DEM, which I understand was not the case.
- P8: Line 8: "As the geometry of the breach is not independent, it was not considered as a parameter for scenario development". As mentioned above this contradicts another statement. Also, the geometry is independent of the water levels, the failure is not.
- P9, figure 6: Why is the middle chainage higher than the others during the rising limb? This raises more questions about the boundary conditions.
- P10, Line 13: The 1:25yr design criteria should be mentioned in the abstract and introduction, as it dictates the method and outputs.
- P10, line 18: from which direction is the angle measured, i.e. does angle of landfall of 230 degrees indicate a cyclone moving from South to North? Apologies if this is an obvious question, but I am not hugely familiar with cyclones.
- P10, Line 34: "Single breach was considered for each scenario". English. Also, perhaps the authors can suggest the consequences of the assumption of 1 breach for a 1/25yr storm. Is 1 an over or under estimate? How many breaches have been recorded before?
- P11, line 8; English
- P11, line 10; It is important to clearly identify what the maps and outputs represent. For example the PFMS are probabilistic inundation maps for a single event (1/25yr) in which a breach occurs.
- P12, line 23; The fact that you do not account for duration or velocity of inundation should be mentioned, especially if highlighting their importance.
- P14, line 2. English
- P14, line 7; "P_{fj} is the probability of reaching a certain storm surge level in simulation number j". Is each P_{fj} will be equal to 1/25 here? As mentioned I think it is important to specify these results relate to the 1/25yr level.

Results and Discussion

- P15, line 6: "...for identifying 5 the critical location of breaching". This could be confused as a process to identify locations for the modelling process. Consider revising, and/or changing to 'regions'.
- P16, figure 9: Presumably these figures are averages of subsets of the 72 simulations, This should be indicated in the text.
- P16, line 3: Now the authors move back to the subset of 3 scenarios. I find this hard to follow, especially since the names 'scenarios 1,2, and 3' do not relate to any cardinal numbers, but to breach locations on the west, centre and east.
- P18, figure 11: This figure and figure 10 need clarification. Can I infer from them that the area in which the maximum flood depth was less than 0.1m in scenario 1 (western breach) had an inundation of just above 2km², which causes about 400,000 euros of damage? I see this is later explained in the discussion, but the authors might consider a clearer explanation at this point too.
- P18, line 3: Section 4.5 describes how the western breach was selected as the critical location, but you should mention that result here, as the flood map is clearly dependent on that. Perhaps it should also be plotted in figure 12 as well.

- P19, line 8; “This arbitrary threshold...”. It has just been explained that the threshold is not arbitrary.
- P19, line 8; “...and the estimation of damage due to flood was not affected”. I don’t understand this sentence at all.
- P20, figure 13: Again I think it should be mentioned that this is the 1/25yr PFM.
- P20, line2: “Three worst case scenarios (Scenario 1, 2 and 3)...” Again there is confusion about these scenarios. They are not the 3 worst case scenarios, they are the worst case scenarios in terms of boundary conditions for each of the 3 potential breach locations.
- P20, line 3: “demonstrate that large area is flooded...”. English
- P20, line 4: The text references figure 9, which relates to all 72 simulations, as I understand. This is in the middle of text about the 3 extreme scenarios, and further highlights the issue already mentioned.
- P20, line 5: “More than 25% of the total area of Polder 48 was inundated for the three scenarios...”. Please make this sentence clearer, I understand it to mean ‘At least 25% of the total area of Polder 48 was inundated in all 3 extreme scenarios’
- P20, line 10. It is not quite correct to say the risk is X million euro. Firstly it needs to be defined as a value per year or per event. Secondly these values are only the extreme versions of the 1/25yr event defined.
- P21, line 8: English
- P21, line 10: “due to breaching of unprotected location of the dike”. English
- P21, line12: “Scenario 1 had higher risk of flooding as the damage due to flooding was maximum for Scenario 1”. This sounds strange, consider revising.

Conclusion

- P22, line 1: “investigate inundation pattern in a polder”. English
- P22, line 2: “were compared using total flooded area and estimated damage”. For which scenario set? 72 or 3?
- P22, line 5: “Flood risk map and probabilistic flood map...”. English. These mistakes are very distracting.
- P22, line 8: “during the breaching of central part of the sea facing dike”. It doesn’t happen during the breaching.
- P23, line 8: “Most flooded area had flood depth of 0.1 to 0.5 m...”. English.
- P22, line 20: “...are least and most probable land use respectively”. This sounds strange.
- P22, line 24: This is the first mention of ‘synthetic water level time series’. It is clear from the bottom of figure 6 that they are present, but not how they were generated.
- P22, line 27:” This stresses the importance of field observation pre, post and during event”. I don’ see what actually stresses this importance.
- P22, line 30: “Comprehensive survey should be conducted...”. English.
- P22, line 33 “...a join probability” English
- P23, line 1: “Single breach was considered for all the developed Scenarios”. English
- P23, line 2: “...should be studies as well”. English
- P23, line 7: “Conducting field survey to generate these curves...” English