Review of NHESS-2021-329

Title: Storm surge hazard over Bengal delta: A probabilistic-deterministic modelling approach

The paper mainly has shown an application of the hydrodynamic model SCHISM combined with a large ensemble of synthetic storm events generated for the Bengal delta region based on the climatic conditions of the 1981-2015 period for flood risk analysis. I want to applaud the authors for their sheer volume of work. This study will undoubtedly contribute to the storm surge risk awareness of the coastal community and the region's local government; however, I have a few questions about some of the methods used in the analysis. Also, some sections throughout the paper need more details and better clarity to improve the model results' reliability before considering it for publication.

Questions are written below using page numbers and text quoted from the main body.

Specific comments:

1. The author has mentioned about a custom high-accuracy regional bathymetry data a couple of times. Is there any study done to check the quality of the data itself (i.e., accuracy)? Is it publicly available?

2. In page 12, lines 284-285: *'With an average annual frequency of 0.70314 cyclone, the ensemble of 3600 cyclones considered here ...'*

   What is the main reason behind selecting 3600 cyclones? Why this number?

3. These synthetic tracks are considered equivalent to 5000 years of storm activity to estimate the storm surge-induced water level at various return periods. Is it possible to identify any relationship between the return period of the maximum storm intensity and the surge water levels from the synthetic track properties? It could help recognize the role of different storm properties such as the maximum storm intensity and track translation speed in generating the surge level.

4. In page 9, lines 222-223: *'Following their findings, we have used a combination of Emanuel and Rotunno (2011) and Holland (1980) formulations to derive the parametric wind profile.'*

   The Holland model's parametric wind and pressure field representation could generate unrealistic storm surge, especially when the track is slow-moving before the landfall and has higher intensity. As the study depends heavily on this atmospheric representation, it is crucial to show additional verification here. The author could add a comparison of the surge level generated during a historic event (e.g., cyclone Sidr), using a global reanalysis wind dataset (e.g., ERA5) and the parametric representation used in this study. This analysis can show the maximum surge bias using the parametric wind model and add more credibility to the later results.

5. In page 16, lines 367-369: *'The inundations in the mangrove region around 89.5°E seem to have a large saturation effect ... slightly rising from 2.5m at 50-year return period to 3m at 500-year return period'*

   If we compare the water level during Sidr in Figure 3 with Figure 6, we can see that close to 89.9 and 22 the floodwater during Sidr represents a 250-500 yr event. Is it realistic? How does it compare with the historical information?

6. In page 16, lines 382-383: *'Along the Hooghly estuary, the sensitivity of the water level to the return period is moderate for the first 100km but amplifies considerably further upstream.'*

   Why do we see almost no change for 50 and 500 yr events at the downstream side, but then it shows a significant increase for the upstream part? How is this surge generating there?

7. In page 20, lines 429-431: *'We have first extracted the tidal water level from the 3600 cyclones that we simulated ... our estimation of surge amounts to 1.8m at Hiron point.'*

   This extraction needs to be explained better before going into the comparisons. How did the author separate the surge during high and low tides? Sometimes, the residual

(total water level - tides) during a low tide could be higher than the residual during a high tide, and it doesn't necessarily represent flooding.

8. In page 20, lines 441-442: *'However, the limited and potentially biased sampling of the "strongest" cyclones (17 in total, over 40 years) leads to an overestimation of the storm surge level.'*

   Jakobson et al. (2006) estimated the return period water levels using historic storms; here, we are looking at synthetic cases in this study. I don't think it is a fair comparison here.

9. In page 21, section 5.4: *'The maximum modelled water level reached about 5m around (88.4°E), which corresponds to a 250-year return period.'*

   Again, the statement here is from the results of this study. Can we verify it?

10. In page 22, section 5.6

    Before delving into this analysis, the author needed to show some model overland inundation comparisons with the high water mark data sets for a storm event. Otherwise, there is no way to verify this crucial information and could be misleading because of the potential inaccuracies in the topographic data.

Other comments

1. In page 4, line 95: *'Additionally, the storm parameters ...'*

   What are these parameters?

2. In page 6, section 2.1

   The model runs are in 3D? If so, how many sigma layers are used? Also, how the Coriolis force is defined in the domain?

3. In page 10, line 248: *'... the time of landfall by half-an-hour to get a better match of the tidal propagation'*

   Surge propagation?

4. In page 11, Figure 3

   Please show the cyclone Sidr track on top of Figure 3a.

5. In page 13, lines 306-307: *'Second, with wind and pressure fields ... hindcasts described in the previous section.'*

   Do the tidal forcings also match the timeline of the synthetic storms?

6. In page 14, line 347: *'According to the polder embankments dataset used ...'*

   How are they incorporated into the current model setup?

7. In page 15, lines 356-357: *'... contrasting range of MHW along the shoreline – with two macrotidal poles ...'*

   A tidal MHW map needs to be added to Figure 5 as a subplot to illustrate this better. It will also help the description written in section 5.2.

8. In page 19, line 400: *'This landfall pattern corresponds to previous observations that the landfalling cyclones in the Bangladesh coastline tend to move north-eastward (Ali, 1996).'*

   Does the JTWC observed data also support this statement?